Diabetes morbidity after displacement[a]

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Abstract

We investigate how career disruptions in terms of job loss may impact morbidity for individuals diagnosed with type 2 diabetes (T2D). Combining unique, high-quality longitudinal data from the Swedish National Diabetes Register (NDR) with matched employer-employee data, we focus on individuals diagnosed with T2D, who are established on the labor market and who lose their job in a mass layoff. Using a conditional Difference-in-Differences evaluation approach, our results give limited support for job loss having an impact on health behavior, diabetes progression and cardiovascular risk factors.

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1 Introduction

We analyze the effect of job loss on the progression of type 2 diabetes (T2D), health behavior, and cardiovascular morbidity for individuals diagnosed with T2D using unique longitudinal data from the Swedish National Diabetes Register (NDR) linked with matched employer-employee data.

There is a large literature that documents scaring effects on labor market outcomes from being displaced that surpass the initial drop in income (see, for example, Ruhm 1991; Jacobson, LaLonde and Sullivan 1993; Stevens 1997; Couch and Placzek 2010), as well as health consequences from job loss (see, for example, Sullivan and von Wachter 2009; Eliason and Storrie 2009a; Browning and Heinesen 2012; Bloemen et al. 2018). Job displacement may affect health through a number of pathways: Increased stress, associated with reduction of income and the change in life, can have a direct impact on health (Stansfeld et al. 2001; Hemingway and Marmot 1999; Knol et al. 2006); individuals may change daily routines and develop a different lifestyle due to the social consequences and loss of income; job loss can reduce access to health care due to loss of employer provided health insurance; loss of health insurance coverage, increased mobility, and change of health care provider can also reduce the quality of care due to disruptions in the continuation of care.

When studying displaced workers in Pennsylvania in the 1980's, Sullivan and von Wachter (2009) found that mortality risk increased by 50–100 percent during the year of the layoff, and that the annual mortality hazard was 10–15 percent higher even 20 years after the displacement. Exploratory analysis suggested that workers with larger earnings losses and larger variability in earnings suffered greater increases in mortality risk.

Studies with European data however find slightly smaller, and more mixed, results on mortality and hospitalization.[2] This indicates that job loss may have different

[2] Eliason and Storrie (2009a) find a 44 percent increase in overall mortality 1-4 years after the job loss, but no effects for women and no effects beyond four years. Bloemen et al. (2018) similarly find a 34 percent increase in the mortality of Dutch men within five years of a layoff. Browning and Heinesen (2012) find similar short run effects, and an 11 percent increased overall mortality up to 20 years after displacement studying Danish men. Roulet (2018) finds negligible effects of job loss on mortality and hospitalization in Denmark. For Norway, Rege et al. (2009) find increased short run mortality 1-6 years after displacement whereas Martikainen et al. (2007) find no mortality effects for Finnish men and women. The increased mortality is mainly due to self-inflicted deaths, traffic accidents, alcohol related deaths, circulartory discease and psychiatric conditions (Browning and Heinesen 2012; Eliason and Storrie 2009a). Job loss tend to increase hospitalizations due to traffic accidents, alcohol related disease and self-harm (Browning and Heinesen 2012; Eliason and Storrie 2009b), but not psychiatric and stress related diagnoses, and diagnoses related to the circulatory and digestive system (Browning, Dano and Heinesen 2006; Eliason and Storrie 2010). There is also evidence that displacement increase the usage of antidepressant drugs (Kuhn, Lalive and Zweimüller 2009) and disability benefits (Rege, Votruba and Telle 2009).

consequences in a context where the transitory income loss is mitigated through comprehensive unemployment insurance, with active measures to reintegrate unemployed to the labor market, and a universal health insurance.[3] A drawback with many studies in this literature is that they either use crude health conditions, or indirect measures that are potentially affected by displacement. For example, unemployed individuals have fewer time constraints in consuming health care services. This makes it difficult to pin down the pathways. More recent studies aim to overcome this by using measures of self-reported health (Black et al. 2015; Schaller and Huff-Stevens 2015), health behavior (Falba et al. 2005; Marcus 2014; Monsivais et al. 2015) or biomarkers for less severe conditions (Black et al. 2015; Michaud et al. 2016).

In this paper, we study the short run effects—0–1 years after displacement—of being laid off from work on health behavior (body weight, smoking, and physical exercise), disease progression (HbA1c), and cardiovascular co-morbidity (hypertension and high cholesterol) for patients diagnosed with T2D. We study a combination of biomarkers and survey information for a common chronic disease usually diagnosed and managed in the primary care. T2D is caused by bad control of blood glucose levels either by being insensitive to the insulin being produced or an abnormal insulin secretion. If the diabetes is not properly managed it leads to hyperglycemia, or raised blood glucose, which damages the blood vessels. Over time this can lead to severe side effects such as heart disease and stroke.[4] In Sweden 4–5 percent of the population has diabetes, of which 85–90 percent is T2D (Gudbjörnsdottir et al. 2011).

Individuals with T2D are interesting since they are a potentially vulnerable patient group that is susceptible to additional shocks. Stress following a job loss can have a direct influence on the blood glucose level both by increasing insulin resistance and impairing the production of insulin (Björntorp 2001; Rosmond 2003; Östensson 2010). The change in social context may affect how well individuals control their diabetes; e.g. in checking the blood glucose levels or in planning healthy meals. Life style changes implying weight gain, less physical exercise and increased smoking also increases

[3] Eliason and Storrie (2006), Huttunen et al. (2011) have documented moderate long run effects on earnings in Sweden and Norway, but there may still be lasting costs in terms of leaving the labor market (Huttunen et al. 2011), receiving disability benefits (Rege, Votruba and Telle 2009), or remaining unemployed (Eliason and Storrie (2006).

[4] Other side effects include diabetic retinopathy which can lead to blindness; kidney failure; diabetic neuropathy which can lead to foot ulcers and limb amputation.

insulin resistance and reduces the production of insulin, thus impairing the control of blood glucose elevations (Hamman 1992; Socialstyrelsen 2011).

Moreover, our setting is interesting since it reduces the potential of many pathways: Workers on the Swedish labor market are generally covered by comprehensive unemployment benefits limiting the financial consequences of unemployment; active labor market policy (ALMP) provided by the Public Employment Service facilitating the transition back into work; the public health insurance covering health care services and pharmaceuticals drugs ensuring that there is no discontinuation of health insurance coverage at displacement. As T2D is a chronic and deteriorating disease, individuals with T2D generally have an established and regular contact with the health care system where the disease is closely monitored (typically by a diabetes nurse in the primary care) and the optimal mode of treatment re-evaluated regularly. Hence, our setting can give an indication whether existing policies can counteract the health hazards of job loss, even for a group that is particularly susceptible to labor market shocks.

We study job losses for the period 2006–2009 and in order to take the endogeneity of individual layoffs into account, we only use individuals who leave the workplace during a mass layoff (von Wachter 2009). In our main analysis we combine this with a conditional Difference-in-Differences (CDD) strategy that merges a matching approach with taking differences at the individual level (Heckman et al. 1998) thereby utilizing the longitudinal nature of the NDR-data.

Overall, we find limited support for job loss having an impact on health behavior, on diabetes progression, and on cardiovascular risk factors. The effects of job loss on changes in BMI, physical activity, and smoking are small or negligible for men, while results are more inconclusive for women. Also with respect to the blood glucose level the effect of job loss is on average limited, but in sub analyses for men with T2D who remain non-employed we find indications of higher blood glucose levels after displacement. The results for cardiovascular risk indicators are more difficult to interpret since the parallel trends assumption, underlying the analysis, may not be fulfilled. When accounting for deviating trends using a conditional triple difference (C3D) strategy the likelihood of high cholesterol does not increase with job loss, and for hypertension the results suggest an increasing effect for men but no effect for women. Overall, this suggests that there may be scope to limit, or cancel out, the negative health consequences of job displacement with comprehensive unemployment insurance and ALMP that limit the economic consequences of job loss, with universal health insurance, and by monitoring health of displaced workers, even for groups of individuals whose background health could make them highly vulnerable to labor market shocks.

Our paper is most closely related to Black et al. (2015) who use data from a Norwegian health survey and find that displacement due to a mass layoff increase smoking but find no effects on collected biomarkers such as cholesterol or blood pressure. It is also related to Schaller and Huff-Stevens (2015) who in a US context find that involuntary job loss leads to a decline in self-reported mental (depression and anxiety) and physical health, but does not affect the incidence of diabetes, arthritis, hypertension, heart disease and high cholesterol in the first two years following job loss, and to Michaud et al. (2016) who find weak evidence that involuntary job loss impacts biomarkers for physiological dysregulation using US data. These results suggest larger consequences of job displacement in a US milieu. A major difference to these papers however, is that while we are studying the progression of a chronic disease, they study incidence in the general population.

In section 2 we describe the institutional setting in Sweden with respect to unemployment insurance, health care system and diabetes care. In section 3 we present the data and empirical strategy, followed by results in section 4. In the final section we summarize the results and conclude. In the Appendix we report supplementary results.

2 Institutional setting

2.1 Unemployment benefits

The unemployment insurance in Sweden is organized through 36 independent unemployment insurance funds covering different professions or types of work. Membership is voluntary and 71–83 percent of the Swedish labor force was members of a fund during the period we are studying (IAF 2016). The government regulates the insurance and decides on the benefit levels, and the Public Employment Service has an active function in controlling that the entitlement conditions of the unemployed are fulfilled.

In order to be eligible for benefits from the Swedish unemployment insurance a worker needs to be a member in one of the unemployment insurance funds and to fulfill (a) the basic criteria of being registered as unemployed at the Public Employment Service and to be actively searching for a job, and (b) the work criteria of having been gainfully employed for at least 6 months[5] within the 12 month period immediately preceding the start of unemployment (SFS 1997:238). The benefit period is 300 days, and an unemployed individual only fulfilling the basic criteria received a basic insurance amount of 320 SEK per day in 2008. If, additionally, the work criteria is fulfilled, he/she received 80 percent of the previous earnings up to a cap (SEK 680 per day in 2008) for the first 200 days of the insurance spell, followed by 70 percent of the earnings until day 300 (Sibbmark 2008). The unemployment insurance is financed both through the tax and through members' own contributions.

Many workers are also covered by additional unemployment compensation agreed upon in collective agreements between employers and unions (Sjögren Lindquist and Wadensjö 2005). The exact form of these compensations varies by sector, agreement area and the reason for unemployment. For tenured workers in the public sector and private white collar workers this compensation typically tops up the unemployment insurance over the cap, so that the unemployed individual receives 70–80 percent of the previous earnings, whereas blue collar workers can receive a lump sum severance payment. In special cases, the collective agreements also provide early retirement benefits from 60 years of age.

2.2 Health care system

All Swedish residents are covered by a public health system providing inpatient and outpatient hospital care, prescription drugs, primary healthcare, dental care for children and adolescents, public health and preventive services. Health care services are managed by the 21 county councils, regional political bodies that levy tax and have responsibility for the health care of its inhabitants.[6]

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[5] 6 months employment of at least 80 hours per calendar month, or 480 hours during a consecutive period of 6 months and at least 50 hours during each of these months.

[6] About 3 percent of the Swedish population had some form of private health insurance during the period we are studying (Sveriges Kommuner och Landsting 2012). These insurances are, however, limited in coverage and can at most be seen a complement to the public health care system. They do not cover acute care, chronic conditions or expensive treatment. The idea is instead to provide fast access to primary care and to enable remittance to specialist care in the public system to avoid waiting time, and to limit the risk for long sickness absence for self-employed and key employees.

The provision of health care services is centered on community based primary care clinics, local hospitals and regional highly specialized university hospitals, where the primary care has a role to act as a gatekeeper that remits patients to specialists. Patients are provided cost sharing and have to pay user fees when visiting the primary care or hospitals, but these were capped at SEK 900 annually in 2008. Similarly, there is a co-payment for prescriptions drugs where the patient pays a successively lower share up to a cap at SEK 1800 annually in 2008. These caps are installed to make access to health care less sensitive to income and employment status.

2.3 Diabetes care

The diabetes care in Sweden is often based on an individualized care plan and centered around annual meetings with a physician or a diabetes nurse (Socialstyrelsen 2017). The patient is scheduled for these meetings by the responsible diabetes nurse to ensure continuity of care. The patient is called more often when the diabetes is newly diagnosed and if the patient has an impaired metabolic control, or if the physician is optimizing the treatment.

At these visits, the patient takes a blood test to evaluate the blood glucose level (e.g. HbA1c and fasting blood glucose) and clinical risk factors for co-morbidity (e.g. cholesterol). The patient is physically examined, and the patient's self-assessed health and habits (e.g. smoking, physical activity, diet and alcohol habits) are followed up. Based on this, the progression of the diabetes is assessed and the risk for complications from diabetes (e.g. cardiovascular risk and stroke) is evaluated.

The optimal mode of treatment is then re-evaluated. If deemed necessary, the patient may also be referred to another specialty (e.g. an ophthalmologist). In many county councils the diabetes care is coordinated in a multi-professional team including dieticians, chiropody therapists, curators and physiotherapists.

3 Empirical strategy

When assessing the effects of losing a job, the methodological problem consists of the nonrandom feature of layoffs. Workers with lower productivity and worse health are generally more likely to be laid off, resulting in the lack of comparability of the average displaced and non-displaced individual.[7]

To evaluate how the progression of T2D is affected by dismissals, we need to nevertheless find a way to be able to compare the morbidity of displaced individuals to that of non-displaced individuals. This means that we have to take care of any endogeneity in the displacement process; e.g. that individuals with more progressed diabetes are more likely to be laid off. To this end we use displacements where a large share of the employees at a workplace is laid off at the same time. At large layoffs employers may not be able to be as selective in whom to displace, especially if they are bound by seniority rules.[8] In the analysis, we compare individuals diagnosed with T2D who are separated from their workplace at a mass layoff, to non-separated individuals with T2D at workplaces where no mass layoff is taking place.

Workers who are displaced in mass layoffs may, however, still not be a random group. Individuals with certain characteristics—including traits related to their health background—can be more likely to select into specific firms and sectors facing different business risk. Workers in certain sectors may also be directly exposed to diabetes related risk factors; e.g. workers at fast food restaurant are more exposed to cheap calories. Finally, even in mass layoffs there can still be some leverage for firms to dismiss the less productive and less healthy workers. Therefore, in addition to restricting attention to mass-layoffs, we exploit the richness of the Swedish register data with respect to firm level and individual level information to control for selection on observables by matching on propensity scores with inverse probability weighting (IPW).

In the analysis we additionally take advantage of longitudinal information on diabetes morbidity and combine the IPW procedure with difference-in-differences; see, for example, Heckman et al. (1998), Bergemann et al. (2009) for conditional

[7] In principle the seniority rules in the Swedish labor market—stipulating that workers with shortest tenure at a workplace are laid off first—reduce the employers' ability to selectively displace workers, but the Swedish labor market legislation is only "dispositive" in the sense that an employer can make agreements with the local union to deviate from "last-in-first-out" principle (SFS 1982:80, 2 §). Employers also have some leverage over which workers to apply the seniority rules (Glavå 1999, p513ff). Firms with less than ten employees also have special rules allowing them to exempt two key-workers from the last-in-first-out rule (SFS 1982:80, 22 §). We therefore restrict the analysis to workplaces with more than 10 employees.

[8] While most workers leave a workplace involuntary during a mass layoff, some workers with better health and labor market prospects may leave the workplace voluntary. Using only administrative data it is difficult to distinguish displaced workers from those who leave voluntary, and to the extent that there are voluntary movers this may lead us to understate the effect of layoffs.

Difference-in-Differences (CDD). In exploiting the panel dimension, we account for both observable and unobservable factors related to layoffs and diabetes morbidity. We thereby analyze if the change in diabetes morbidity is faster among displaced individuals than among those non-displaced, where the identifying assumption is that the rate of progression, conditional on covariates, would be the same in absence of dismissals. In a sensitivity analysis, we extend this to a conditional triple differences (C3D) approach, assuming that the treated and matched controls are on different trends with respect to the outcome variable.

Information on diabetes prevalence and morbidity that we use to define our study population and to measure outcomes is obtained from the Swedish National Diabetes Register (NDR).

We combine information from different register data sources. The matching is possible since all Swedish residents have a unique social security number that defines their identity.

3.1 Defining mass layoffs

We use Swedish matched employer-employee data to define displacements. This data contains annual information for all workplaces on yearly wage earnings paid to each employee; information which a firm is mandated to report to the authorities for tax purposes. Workplaces and individuals have unique identifiers used by Statistics Sweden that enables us to track the workplaces and their employees over time.

We sample all workplaces with more than 10 employees[9] on the Swedish labor market for the period 2005-2008.[10] A workplace is considered to have experienced a mass layoff if the workforce is reduced by more than 30 percent between the year the workplace is sampled and the subsequent year.[11] We define the year of the potential layoff to be year t, which means that workplaces are sampled at year t-1. Since downsizing can be a prolonged process over several years we restrict our attention to workplaces that have not experienced a yearly reduction in workforce, in the two-years preceding sampling, of more than 30 percent (i.e. t-3, t-2). Thereby, we reduce the risk

[9] See footnote 7.

[10] We follow Kopczuk, Saez, and Song (2007) in excluding agriculture, forestry and fishing. In addition, we exclude workplaces for domestic housekeeping, and foreign embassies and international organizations located in Sweden.

[11] We follow, for example, Jacobson, LaLonde and Sullivan (1993), Sullivan and von Watcher (2009), and von Wachter, Song and Manchester (2011) in defining mass layoffs as an employment reduction with at least 30 percent below a baseline employment level. In a literature survey von Wachter (2009) notes that, although arbitrary, the 30 percent definition is the most common and that estimates are largely robust around this definition.

that workers selectively leave their employment in anticipation of a mass layoff or have been affected by a previous labor market shock.[12] By restricting attention to stable establishments we lose about 5 percent of the workplaces.

An individual is considered to be employed at a workplace in a specific year if he/she receives wage earnings of at least the implied Swedish minimum wage (Skedinger 2005) in December that year.[13] We choose a fairly high threshold for the wage earnings to define employment because we want to capture individuals with a relatively strong attachment to the labor market, for whom job loss will impose a major change in the economic and social circumstances. By defining employment with wage earnings in December, individuals who become displaced in year t may be separated at any point during that year, with some individuals exposed to the job loss for most of year t, whereas others have been exposed for a shorter period.

A potential problem of identifying layoffs with administrative data is the risk of misclassifying reorganizations, firm takeovers and mergers—where the workplace identifier changes—as mass layoffs, see, for example, Kuhn (2002). To avoid such misclassification we require that not more than 30 percent of the "old" coworkers in t-1 may end up together at another workplace in t for a workplace to be defined as having experienced a mass layoff.

Among the sampled establishments about 6 percent of the workplaces have a mass-layoff in the subsequent year. The potential control groups consist of all workplaces not having experienced a mass-layoff.

We then sample all individuals aged 40–60[14] at these workplaces two years before the potential layoff (i.e. t-2) who have been diagnosed with T2D, and only retain workplaces with at least one employee with T2D in t-2. By sampling employees at

[12] Sullivan and von Wachter (2009) note that it may be difficult to assign the year for a distinct shock in the case of gradual employment reductions at the firm level. We are sampling stable establishments to avoid workplaces that are in a prolonged process of downsizing where it is difficult to both pin down a specific time point for the major layoff and at what point the employees would have been unaware of the upcoming cutbacks.

[13] For every workplace the employer-employee data contains information on the annual wage earnings paid to each employee and the first and last month for which the wage is paid. Using this information, we can calculate the approximate wage earnings in December for everyone receiving wage that month, as the average monthly wage over the months with wage payments (i.e. between the first and last month). For individuals receiving wage earnings (in December) from multiple sources we select the workplace where he/she has the highest earnings. The wage cutoff that we use to define employment is based on the (CPI deflated) Swedish minimum wage for 2004; Skedinger (2004) has extracted minimum wages on the Swedish labor market as stipulated by collective agreement for different industries. We use the lowest minimum wage recorded 2004 amounting to SEK 12,786 (the highest minimum wage was 15 341 SEK).

[14] Older individuals are more likely to leave the firms because of (early) retirement. As we cannot determine the reason why an individual left the firm we exclude the older individuals.

workplaces two years before the potential layoff we reduce the risk of anticipation effects as information about an upcoming layoff may become available 1–6 months before the layoff through advance notices to affected employees and pre-notification to the Public Employment Services.[15]

3.2 Diabetes prevalence and morbidity

We define the study population and retrieve outcome measures based on information available from NDR.

NDR is a medical quality register managed by the Swedish Society of Diabetology and was initiated in 1996 to support evidence-based treatment of diabetes, by offering the medical profession up-to-date information about changes in the treatment of glycaemia, diabetic risk factors, diabetic complications and overall morbidity. The register contains annual information on treatment, morbidity, progression and side effects for all individuals recorded in NDR.

The register is based on a local organization of participating clinical departments of medicine and primary care centres. Participation by these facilities is not mandatory; still in 2010 compliance was over 95 percent for hospitals and around 90 percent for the primary care. The registration of information for individual patients is generally carried out by a nurse educated in diabetology or by their physician—a specialist in endocrinology or internal medicine, or a general practitioner. The data entry is managed using either a printed form, a specific computer software, or via a web interface on the Internet. Each patient has to give his consent before being included in the register. Any non-compliance of diabetes patients to the register thus comes from two sources: either the diabetes patient has a physician who is not working at any of the health care facilities collaborating with NDR, or the patient has declined to participate in the register. We have data on diabetes until 2010, when NDR covered 80 percent of the Swedish diabetes patients (Gudbjörnsdottir et al. 2011).[16]

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[15] At a layoff the Employment Protection Act (SFS 1982:80, 11 §) stipulates that the employer must give the employee(s) 1-6 months of advance notification at a layoff depending on employment tenure. The notice time can be extended through collective wage agreement or in the employment contract, but in practice it typically follows what is stipulated in the Employment Protection Act. At layoffs of more than 4 employees, the employer also needs to pre-notify the Public Employment Services 2-6 months before the reduction comes into place depending in the size of the intended layoff (SFS 1974:13). Hence, employees would know of an imminent layoff at their workplace 2-6 months ahead, and an individual knows if he/she will be laid off 1-6 months before the displacement.

[16] The coverage of NDR has rapidly increased over time to 18/43/80 percent in 2001/2006/2010 (Gudbjörnsdottir et al. 2007, 2011).

3.2.1 Study population

The analysis is based on all individuals with diagnosed T2D in the period 2004–2007, who are observed in NDR two years before a potential layoff (i.e. in t-2). We then follow these individuals year-by-year until the year after the potential layoff (t+1).

When sampling individuals we follow the recommendations by NDR to use an epidemiological classification of diabetes: A patient is defined as having T2D if he/she is either (1) treated with diet, with or without the use of oral antihyperglycemic agents, or (2) treated with insulin, with or without the use of oral antihyperglycemic agents and has a debut age of 40 or older. The epidemiological categorization has a good correspondence with the clinical classification of diabetes (Gudbjörnsdottir et al. 2011).

3.2.2 Outcome variables

Losing a job can affect the progression of diabetes for several reasons. The stress following job loss can have a direct influence on the blood glucose level (Björntorp 2001; Rosmond 2003; Östensson 2010), and the change in social context may affect how well individuals control their diabetes; e.g. in checking the blood glucose levels or in planning healthy meals. The individual may also resort to destructive coping strategies to handle the stress and changed socioeconomic circumstances. On the other hand, an individual losing their job does not suffer from work related stress and has more time to manage the disease.

We use three types of outcomes: Whether individuals' own health behavior is changed because of the displacement, whether the diabetes is progressing to a deteriorated state, and the presence of cardiovascular risk factors.

An individual's lifestyle is an important part of managing the disease: Job displacement may affect factors determining lifestyle choices (see, for example, Deb et al. 2011 and Eliason and Storrie 2009a). We analyze effects on physical activity, body weight and smoking. More physical exercise and a lower body weight stabilizes the blood glucose level, by increasing the production of insulin and the sensitivity to insulin (Hamman 1992; Socialstyrelsen 2011). Smoking on the other hand may lead to increased insulin resistance, thereby increasing the risk for complications (see Eliasson 2003, Nilsson et al. 2009).

In managing the diabetes, the goal is to control the blood glucose levels. We therefore analyze if job loss affects the blood glucose levels. We look directly at the effect on HbA1c (measured in percent), which is an overall measure of the blood glucose level over a period of 6–8 weeks. From NDR we have annual information on HbA1c.

High blood glucose levels over long periods of time lead to blood vessels becoming damaged. If the diabetes is not properly managed the elevated blood glucose can lead to a range of chronic complications. Having diabetes increases your risk of developing high blood pressure and other cardiovascular problems.[17] Diabetes also tends to raise the bad cholesterol and lower the "good" cholesterol, which increases the risk of heart disease and stroke. We analyze if job displacement affects the likelihood of hypertension and cardiovascular risk related to high cholesterol levels. In the analysis a patient is defined as having hypertension with a systolic pressure of at least 140 mmHg; or a diastolic pressure of at least 90 mmHg, or if he/she is taking medication for blood pressure (Chobanian et al. 2003, Australian Heart Association 2016), and high cholesterol with LDL of at least 2.5 mmol/l or is prescribed lipid lowering medication (Eldor and Raz, 2009, Moberg, Tovi and Litnäs 2017)

3.3 Estimation strategy

In our main analysis we apply the CDD estimation technique that combines matching with taking differences on the individual level in order to estimate the treatment-on-the-treated effect.

If we were to use a pure matching approach, we would need to invoke the conditional mean independence assumption (CIA), or unconfoundedness: Conditional on predetermined covariates, treatment would need to be unrelated to the nontreatment outcomes. It is then assumed that $E(Y_0|X,D=1) = E(Y_0|X,D=0)$, with Y_0 being the nontreatment outcome, X covariates and D the treatment indicator. This is a strong assumption, as it presumes that all the covariates that simultaneously determine the treatment status and the outcome are known and observed.

We therefore build our analysis on a weaker assumption, the so-called conditional bias stability assumption (BSA) that assumes that selection on observables holds but only conditional on an individual specific fixed effect. Consequently, we allow for selection on observables as well as time invariant selection on unobservables: $E(Y_{0,t}$ –

[17] The Framingham Heart Study (Kannel and McGee, 1979a, 1979b) found that the incidence of cardiovascular disease was 2-3 times higher among diabetics that non-diabetics.

$Y_{0,t-1}$|X,D=1) = E($Y_{0,t}$ – $Y_{0,t-1}$|X,D=0), with t denoting an after period and t-1 denoting a before period. One can also interpret the BSA as a common trend assumption, as it assumes that the mean of the nontreatment outcome exhibits the same trend for the treated and the matched untreated (see also Andersson et al. 2013, Bergemann et al. 2009 and Lechner 2010).

In sensitivity analyses, we extend this to a C3D approach assuming that the trend differences before treatment between treated and matched nontreated stay constant over time, i.e. E($Y_{0,t}$ – $Y_{0,t-1}$ – ($Y_{0,t-2}$ – $Y_{0,t-3}$) |X,D=1) = E($Y_{0,t}$ – $Y_{0,t-1}$ – ($Y_{0,t-2}$-$Y_{0,t-3}$) |X,D=0), where t-1 is a baseline before treatment period and where t-2, t-3 are additional before treatment periods. We apply this approach to investigate how the results change in case we find evidence that the common trend assumption may not hold.[18]

We follow the literature and implement the CDD approach by estimating a propensity score for being laid off using a flexible probit model with a large variety of covariates (see section 3.4). This builds upon a result by Rosenbaum and Rubin (1983) which shows in the context of the CIA that conditioning on observables is equivalent to conditioning on the propensity score, i.e. E(Y_0|P(X),D=1) = E(Y_0|P(X),D=0). We then match on the propensity score using IPW. In case we would use the pure matching approach, this would result in the following estimation equation:

$$\hat{\Delta}_{TT} = \frac{1}{n_1}\sum_{i=1}^{n} Y_i D_i - \frac{1}{n_0}\sum_{i=1}^{n}\left(\frac{1}{n_0}\sum_{i=1}^{n}\frac{\hat{P}(X)(1-D_i)}{1-\hat{P}(X)}\right)^{-1}\frac{\hat{P}(X_i)Y_i(1-D_i)}{1-\hat{P}(X_i)},$$

with n_0 denoting the number of untreated units and n_1 denoting the number of treated units. In order to take account of individual fixed effect one replaces the outcomes with the before and after difference of the outcomes:

$$\hat{\Delta}_{TT} = \frac{1}{n_1}\sum_{i=1}^{n}(Y_{t,i} - Y_{t-1,i})D_i - \frac{1}{n_0}\sum_{i=1}^{n}\left(\frac{1}{n_0}\sum_{i=1}^{n}\frac{\hat{P}(X)(1-D_i)}{1-\hat{P}(X)}\right)^{-1}\frac{\hat{P}(X_i)\big(Y_{t,i} - Y_{t-1,i}\big)(1-D_i)}{1-\hat{P}(X_i)}.$$

[18] This is in the spirit of Schaller and Stevens (2015) who also investigate the sensitivity of their analysis with respect to the inclusion of trends.

Similarly, relaxing the parallel trend assumption results in plugging in the double difference yields:

$$\hat{\Delta}_{TT}$$
$$= \frac{1}{n_1}\sum_{i=1}^{n}(Y_{t,i} - Y_{t-1,i} - (Y_{t-2,i} - Y_{t-3,i})D_i$$
$$- \frac{1}{n_0}\sum_{i=1}^{n}\left(\frac{1}{n_0}\sum_{i=1}^{n}\frac{\hat{P}(X)(1-D_i)}{1-\hat{P}(X)}\right)^{-1}\frac{\hat{P}(X_i)\big(Y_{t,i} - Y_{t-1,i} - (Y_{t-2,i} - Y_{t-3,i})\big)(1-D_i)}{1-\hat{P}(X_i)}.$$

The advantage of using the IPW comes from its desirable asymptotic property that under certain condition it reaches the semi-parametric efficient bound and it does well in Monte Carlo studies (see Huber et al. 2013). In addition, there is no need to choose bandwidth or tuning parameters (see Andersson et al. 2013).

We implement the CDD approach in the following way: Our before value is taken two years before the layoff in order to avoid potential anticipation effects. For the C3D we take in addition the difference between t-3 and t-2 as an indicator for trends.

The standard errors are estimated using a Method of Moments estimator. However, the requirement is that the sample is independent and identically distributed. Using potential layoffs for the years 2006–2009 we sample individuals that are not laid off more than once, potentially violating the i.i.d. assumptions. The standard errors do not take this resampling into account. Note that laid off individuals can only be laid off once. In a sensitivity analysis we therefore use a control group consisting of a random sample of 25 percent of the non-laid off in each potential layoff year, making it less likely that we sample non-laid off individuals more than once. These results are provided in Figure A13–Figure A16 in the Appendix.

3.4 Covariates

In order to control for selection on observables we take account of a wide variety of covariates in our matching process. We use potential confounders at the workplace and of individuals.[19]

[19] In Table A1 in the Appendix we report the coefficients from the probit estimation of the propensity, estimated for the sample of individuals with valid observations on “No regular weekly activity”.

We control for demographic and socioeconomic characteristics using information from Statistics Sweden's registers, these data are based on administrative records and population censuses. In the analysis we include age and age squared and type of family, where the family type is defined over the combination of being married, cohabiting, or being single and whether there are children (below 18) or adult children (above 18) in the household. To account for educational attainment, we control for years of education and years of education squared.[20] Using information on country of birth we also include indicators of whether the individual comes from a country with low, or medium/high diabetes prevalence.[21] This can be important since there is an ethnic gradient in incidence, complications and co-morbidities for T2D reflecting biological, behavioral, and social factors (Spanakis and Golden, 2013; Golden et al. 2012).

The severity of diabetes and how strongly diabetes is under control is related to the duration of the illness. An important control is therefore the time since diagnosis. This information is available from NDR.

There is also a clear family component in the pre-disposition for T2D, due to both genetic heritability and environmental factors (including the epigenetic expression) (see, for example, Prasad and Groop 2015; Poulsen et al. 1999). We therefore control for whether the mother, father or any (full) siblings were diagnosed with T2D before the layoff. By exploiting the biological link between parents and siblings, available through the Swedish population register, we can observe if any of the parents or siblings are included in NDR or if they have been discharged from hospital with a main or secondary diagnosis (ICD10) indicating type 2 diabetes.[22]

To account for differences in background health related to productivity we use data from the Swedish Social Insurance Agency to control for the total length of all long-term sickness days 1, 2, and 3 years before the layoff. More specifically, we have annual information on the number of days in sickness insurance for spells lasting longer

[20] The information on educational attainment is based on a 3-digit code, which is a Swedish version of the International Standard Classification of Education 1997. For earlier cohorts covered by this register, and for immigrants, information on educational attainment is obtained from census data, whereas the data for later cohorts come directly from educational registers of high quality.
[21] Provided by the World Health Organisation (see www.who.int/diabetes).
[22] Administrative data on discharges inpatient hospital episodes, including information on primary and secondary diagnoses, classified according to WHO's ICD classification system, is available from the Swedish National Board for Health and Welfare. Hospitals are obliged by law to report this data, and the information is typically entered into the hospital administrative system at discharge.

than three weeks.[23] In addition we use information from the Swedish National Board for Health and Welfare on the number of hospital days and number of hospital episodes in the past 1–3 and the past 4–6 years.

Using information from the matched employer-employee data we include control variables at the workplace level: the size of the establishment (3 categories); broad indicators for industry (7 categories)[24], an indicator for private sector, how long a workplace has been in operation. At the individual level we control for past wage and workplace tenure before the potential layoff. Using occupation data collected by Statistics Sweden through an annual survey covering everyone working in the public sector and about 50 percent of workers in the private sector we also calculate a predicted white/blue collar indicator for everyone in the labor market using information about level and field of education, 5-digit industry and year of birth.[25]

There are large regional differences in labor market conditions across Sweden. We therefore include an indicator for whether the individual lives in any of the major urban cities, and in order to capture differences in job re-allocation and matching we have calculated the labor market tightness on the local labor market: The probability that a worker meets a vacancy increases with market tightness (Mortensen and Pissarides 1994). We use municipal level data on unemployment and vacancies from the Swedish Public Employment Service which we aggregate to local labor markets before calculating the ratio between vacancies and the number of unemployed. [26]

3.5 Descriptive statistics

In Table 1–Table 4 we describe mean values, standard deviations and number of observations of outcomes and covariates, three to one years before, during and the year

[23] All employees in Sweden are covered by the Public Sickness Insurance that reimburses 80 percent of the wage up to a cap, from the second day of a sickness spell. During an initial period of the spell the employer has to pay the benefit; the length of this “sick-pay” period has varied between two and three weeks over the years. After the sick-pay period the sickness benefit is paid by the Social Insurance Agency, and only this part of the sickness insurance is registered in any central registers. During the period relevant for this study the sick-pay period was: 14 days April 1998-June 2003; 28 days July 2003-December2004; and 14 days after January 2005.

[24] Industry codes based on the EUs NACE Rev.1.1 industry classification which we have aggregated to 7 broad industries: Manufacturing; utilities and construction; wholesale; transport and accommodation; information, financial and real estate services; professional services; admin. services; public, education and health services; arts and other services.

[25] Data for the private sector covers all firms with more than 500 employees and a stratified random sample by industry for smaller firms. Information is provided by the employers’ organizations as part of an agreement between unions and the employer organizations. Firms not covered by this agreement are surveyed by Statistics Sweden.

[26] Statistics Sweden uses the following criteria to define labor market regions. For a municipality to become the center of a labor market region two criteria needs to be fulfilled: No more than 20 percent of the residents may commute to jobs in other municipalities, and no more than 7.5 percent may commute to one specific municipality. All other municipalities belong to the municipality to which most residents commute.

after the potential layoff, for the sample of laid-off and non-laid-off workers, as well as the difference between the groups and the standard error of the difference. Individuals included in the analyses are observed (outcomes) two year before the layoff and either at the layoff (t) or the year after the layoff (t+1), or both. The number of observations varies both over outcomes and years since layoff. This is due to the sampling design of our data.

Table 1 and Table 2 display the average values of the outcome variables. Two years before the layoff on average 22 (16) percent of the non-laid off men (women) do not engage in regular physical exercise and 17 (20) percent are smokers. This group has an average BMI of 29.9 (30.4), which results in 88 (82) percent of the group in being overweight and 44 (51) percent obese. The HbA1c level is on average 6.3 (6.2) percent, with 51 (49) percent of the group having an elevated level. Also a high proportion suffer from high cholesterol, 85 (85) percent, and hypertension, 70 (64) percent.

We find some differences in the outcome variables two years before the layoff. For example, the average laid-off man seems less likely to be overweight before the layoff whereas the average laid off woman is more likely to smoke. These differences can be due to a combination of differences in observed and unobserved characteristics of laid off and non-laid off workers that influence both the probability to be laid off and the outcome variables. In order to account for this we employ a CDD in our main analysis. With respect to the development of the outcome variables following a layoff no clear pattern can be detected.

To describe the covariates that enter the propensity score we focus on the sample of men and women that have valid information on the outcome "No regular weekly physical activity at layoff", see Table 3 and Table 4.[27] A large proportion of men (women) with T2D who are not laid off have already been suffering from diabetes for more than 5 years, 59 (59) percent. On average they have 12 (13) years of education. A large proportion of men work in manufacturing (31 percent), whereas women predominantly work in arts, public, education and health services (45 percent). In line with their illness they have a high number of sick days, for example 14 (18) days for men (women) in the year before the potential layoff.

[27] Descriptive statistics for the samples related to other outcome variables look very similar and are available on request.

When comparing characteristics of those who are laid off with those that are not, we find some differences: laid-off men are younger, less educated and earn less. Such differences are not consistent between men and women: laid off women, for example, earn more than non-laid off women.

Table 1. Descriptive statistics of men with respect to the outcome variables

	Laid-off	N	Not-Laid off	N	Difference	Std.
No regular weekly physical activity t-3	0.207	237	0.226	4050	-0.019	0.028
No regular weekly physical activity t-2	0.218	463	0.217	10356	0.001	0.020
No regular weekly physical activity t-1	0.180	334	0.198	7656	-0.018	0.022
No regular weekly physical activity at layoff	0.467	336	0.446	7728	0.021	0.028
No regular weekly physical activity t+1	0.509	348	0.452	7631	0.056*	0.027
Smoker t-3	0.169	325	0.167	7480	0.003	0.021
Smoker t-2	0.170	584	0.173	14410	-0.003	0.016
Smoker t-1	0.205	424	0.168	10546	0.037*	0.019
Smoker at layoff	0.164	420	0.169	10581	-0.005	0.019
Smoker t+1	0.179	441	0.170	10519	0.009	0.018
BMI t-3	29.919	356	29.667	8168	0.252	0.264
BMI t-2	30.015	621	29.856	15262	0.159	0.200
BMI t-1	30.067	478	29.888	11602	0.179	0.226
BMI at layoff	30.076	472	29.935	11725	0.141	0.228
BMI t+1	29.822	469	29.956	11694	-0.135	0.229
Overweight t-3	0.868	356	0.846	8168	0.022	0.019
Overweight t-2	0.884	621	0.859	15262	0.025+	0.014
Overweight t-1	0.877	478	0.862	11602	0.015	0.016
Overweight at layoff	0.873	472	0.866	11725	0.006	0.016
Overweight t+1	0.876	469	0.869	11694	0.008	0.016
Obese t-3	0.430	356	0.420	8168	0.010	0.027
Obese t-2	0.435	621	0.434	15262	0.000	0.020
Obese t-1	0.450	478	0.439	11602	0.011	0.023
Obese at layoff	0.436	472	0.441	11725	-0.004	0.023
Obese t+1	0.435	469	0.445	11694	-0.010	0.023
Glycated haemoglobin t-3	6.193	391	6.313	8823	-0.119+	0.067
Glycated haemoglobin t-2	6.274	667	6.269	16466	0.004	0.052
Glycated haemoglobin t-1	6.358	520	6.292	12671	0.066	0.057
Glycated haemoglobin at layoff	6.430	524	6.405	12977	0.025	0.057
Glycated haemoglobin t+1	6.640	536	6.501	13013	0.139*	0.057
High glycated haemoglobin t-3	0.524	391	0.543	8823	-0.018	0.026
High glycated haemoglobin t-2	0.510	667	0.527	16466	-0.017	0.020
High glycated haemoglobin t-1	0.562	520	0.543	12671	0.018	0.022
High glycated haemoglobin at layoff	0.548	524	0.572	12977	-0.025	0.022
High glycated haemoglobin t+1	0.612	536	0.592	13013	0.020	0.022
High cholesterol t-3	0.864	309	0.887	7036	-0.023	0.018
High cholesterol t-2	0.853	570	0.887	13592	-0.034*	0.014
High cholesterol t-1	0.889	433	0.901	10123	-0.012	0.015
High cholesterol at layoff	0.912	430	0.914	10299	-0.003	0.014
High cholesterol t+1	0.926	443	0.925	10406	0.001	0.013
Hypertension t-3	0.690	361	0.677	8368	0.013	0.025
Hypertension t-2	0.702	641	0.698	15789	0.004	0.018
Hypertension t-1	0.746	489	0.733	11956	0.013	0.020
Hypertension at layoff	0.785	498	0.767	12278	0.018	0.019
Hypertension t+1	0.821	513	0.792	12346	0.029	0.018

Note: +,*,** in ‘Difference’ stands for statistical significance at the 10%, 5% and 1% level

Table 2. Descriptive statistics of women with respect to the outcome variables

	Laid-off	N	Not-Laid off	N	Difference	Std.
No regular weekly physical activity t-3	0.189	53	0.159	2313	0.030	0.051
No regular weekly physical activity t-2	0.150	127	0.156	5655	-0.007	0.033
No regular weekly physical activity t-1	0.170	88	0.136	4213	0.035	0.037
No regular weekly physical activity at layoff	0.292	89	0.366	4303	-0.074	0.052
No regular weekly physical activity t+1	0.383	94	0.376	4209	0.007	0.051
Smoker t-3	0.232	99	0.198	4318	0.035	0.041
Smoker t-2	0.267	187	0.202	8020	0.066*	0.030
Smoker t-1	0.220	141	0.199	6019	0.021	0.034
Smoker at layoff	0.235	136	0.193	5978	0.043	0.034
Smoker t+1	0.215	135	0.193	6008	0.022	0.034
BMI t-3	30.366	99	30.146	4571	0.220	0.609
BMI t-2	30.518	198	30.423	8277	0.095	0.436
BMI t-1	30.549	154	30.347	6398	0.202	0.487
BMI at layoff	29.957	146	30.358	6400	-0.401	0.504
BMI t+1	30.314	145	30.302	6400	0.012	0.500
Overweight t-3	0.808	99	0.798	4571	0.010	0.041
Overweight t-2	0.823	198	0.809	8277	0.014	0.028
Overweight t-1	0.831	154	0.808	6398	0.023	0.032
Overweight at layoff	0.801	146	0.809	6400	-0.008	0.033
Overweight t+1	0.814	145	0.813	6400	0.001	0.033
Obese t-3	0.505	99	0.459	4571	0.046	0.051
Obese t-2	0.505	198	0.480	8277	0.026	0.036
Obese t-1	0.539	154	0.475	6398	0.064	0.041
Obese at layoff	0.459	146	0.477	6400	-0.018	0.042
Obese t+1	0.503	145	0.473	6400	0.030	0.042
Glycated haemoglobin t-3	6.228	110	6.238	5006	-0.010	0.126
Glycated haemoglobin t-2	6.164	214	6.170	9081	-0.006	0.089
Glycated haemoglobin t-1	6.287	166	6.178	7104	0.110	0.094
Glycated haemoglobin at layoff	6.299	164	6.284	7270	0.015	0.097
Glycated haemoglobin t+1	6.423	169	6.388	7355	0.035	0.096
High glycated haemoglobin t-3	0.518	110	0.515	5006	0.004	0.048
High glycated haemoglobin t-2	0.491	214	0.485	9081	0.005	0.035
High glycated haemoglobin t-1	0.518	166	0.500	7104	0.018	0.039
High glycated haemoglobin at layoff	0.530	164	0.520	7270	0.011	0.039
High glycated haemoglobin t+1	0.538	169	0.551	7355	-0.013	0.039
High cholesterol t-3	0.839	93	0.869	3888	-0.030	0.036
High cholesterol t-2	0.851	175	0.874	7365	-0.023	0.025
High cholesterol t-1	0.883	128	0.887	5514	-0.005	0.028
High cholesterol at layoff	0.891	129	0.903	5642	-0.012	0.026
High cholesterol t+1	0.925	133	0.920	5720	0.005	0.024
Hypertension t-3	0.657	102	0.663	4708	-0.006	0.047
Hypertension t-2	0.644	205	0.680	8623	-0.036	0.033
Hypertension t-1	0.703	155	0.719	6627	-0.016	0.037
Hypertension at layoff	0.735	155	0.740	6746	-0.004	0.036
Hypertension t+1	0.727	154	0.763	6840	-0.036	0.035

Note: +,*,** in ‘Difference’ stands for statistical significance at the 10%, 5% and 1% level

Table 3. Descriptive statistics of men with respect to firm and individual characteristics

	Laid-off	Not-Laid off	Difference
Diabetes since ≤5 years	0.406	0.407	-0.001
Age	53.511	54.001	-0.490+
Years of education	11.970	12.363	-0.394*
Firm size			
≤ 100	0.539	0.492	0.046+
101 - 500	0.298	0.314	-0.016
> 500	0.163	0.193	-0.030
Manufacturing	0.334	0.314	0.020
Utilities and construction	0.196	0.105	0.091**
Wholesale, transport and accommodation	0.135	0.154	-0.019
Information, financial and real estate services	0.075	0.111	-0.037*
Professional and admin. services	0.215	0.223	-0.007
Arts, Public, education, health and other services	0.044	0.092	-0.048*
Married or cohab., no children	0.210	0.230	-0.020
Married or cohab., child < 18	0.243	0.250	-0.007
Married or cohab., child≥ 18	0.152	0.137	0.015
Single	0.301	0.304	-0.003
Single with child	0.075	0.064	0.011
Previous monthly wage			
10,000 ≤ x < 15,000	0.091	0.058	0.034*
15,000 ≤ x < 20,000	0.298	0.246	0.052*
20,000 ≤ x < 25,000	0.329	0.330	-0.001
25,000 ≤ x < 30,000	0.166	0.183	-0.017
30,000 ≤ x < 40,000	0.061	0.124	-0.063**
≥ *40,000*	0.055	0.060	-0.005
Private firm	0.870	0.780	0.090**
White collar worker	0.533	0.592	-0.059*
≥ 10 years with firm	0.246	0.261	-0.015
2 - 3 year old firm	0.138	0.078	0.060**
≥ 10 year old firm	0.558	0.626	-0.068*
Sick days, previous year	14.088	12.561	1.528
Sick days, 2 year previous	18.409	15.768	2.641
Sick days, 3 year previous	19.517	16.367	3.149
Hospital days in previous 3 years	1.912	1.456	0.455
Hospital days in previous 4-6 years	1.110	1.308	-0.198
Hospital episodes in previous 3 years	0.348	0.317	0.031
Hospital episodes in previous 4-6 years	0.243	0.289	-0.046
Family member with diabetes	0.362	0.389	-0.027
Vacancy-unemployment ratio	0.544	0.328	0.216**
< 7.4% diabetes rate in country of origin	0.862	0.890	-0.028+
Urban	0.528	0.497	0.030
Potential layoff in 2006	0.014	0.014	-0.001
Potential layoff in 2007	0.072	0.244	-0.172**
Potential layoff in 2008	0.273	0.342	-0.069*
Potential layoff in 2009	0.641	0.400	0.241**

Note: Sample of individuals with valid observations on “No regular weekly physical activity in year of potential layoff”. +,*,** in ‘Difference’ stands for statistical significance at the 10%, 5% and 1% level.

Table 4. Descriptive statistics of women with respect to firm and individual characteristics

	Laid-off	Not-Laid off	Difference
Diabetes since ≤5 years	0.457	0.412	0.046
Age	53.138	53.837	-0.699
Years of education	12.809	12.862	-0.054
Firm size			
≤ 100	0.574	0.531	0.043
101 - 500	0.362	0.296	0.066
> 500	0.064	0.173	-0.109*
Manufacturing	0.202	0.085	0.117**
Utilities and construction	0.053	0.040	0.013
Wholesale, transport and accommodation	0.085	0.053	0.032
Information, financial and real estate services	0.096	0.034	0.061*
Professional and admin. Services	0.277	0.336	-0.060
Arts, Public, education, health and other services	0.287	0.451	-0.164*
Married or cohab., no children	0.340	0.299	0.041
Married or cohab., child < 18	0.170	0.193	-0.023
Married or cohab., child≥ 18	0.128	0.156	-0.028
Single	0.245	0.221	0.024
Single with child	0.106	0.106	0.000
Previous monthly wage			
10,000 ≤ x < 15,000	0.149	0.225	-0.076+
15,000 ≤ x < 20,000	0.404	0.442	-0.037
20,000 ≤ x < 25,000	0.298	0.221	0.077+
25,000 ≤ x < 30,000	0.106	0.067	0.039
30,000 ≤ x < 40,000	0.032	0.035	-0.003
≥ 40,000	0.011	0.010	0.001
Private firm	0.585	0.308	0.277**
White-collar worker	0.681	0.537	0.144*
≥ 10 years with firm	0.117	0.140	-0.023
2 - 3 year old firm	0.085	0.057	0.028
≥ 10 year old firm	0.564	0.731	-0.167**
Sick days, previous year	9.702	18.403	-8.701
Sick days, 2 year previous	19.181	24.943	-5.762
Sick days, 3 year previous	27.468	29.388	-1.920
Hospital days in previous 3 years	1.447	1.006	0.441
Hospital days in previous 4-6 years	0.851	1.193	-0.342
Hospital episodes in previous 3 years	0.309	0.274	0.034
Hospital episodes in previous 4-6 years	0.340	0.292	0.049
Family member with diabetes	0.351	0.408	-0.057
Vacancy unemployment ratio	0.309	0.349	-0.041
< 7.4% diabetes rate in country of origin	0.851	0.887	-0.036
Urban	0.574	0.477	0.098+
Potential layoff in 2006	0.000	0.014	-0.014
Potential layoff in 2007	0.181	0.234	-0.053
Potential layoff in 2008	0.330	0.337	-0.007
Potential layoff in 2009	0.489	0.416	0.074

Note: Sample of individuals with valid observations on "No regular weekly physical activity in year of potential layoff". +,*,** in 'Difference' stands for statistical significance at the 10%, 5% and 1% level.

4 Results

4.1 Baseline results

In Figure 1–Figure 4 we graphically display the estimated effects of being mass laid off in event time.[28] With individuals being sampled two years before the potential layoff, the outcomes two years before displacement (t-2) represent the reference point against which all effects are evaluated. For all outcomes we report effects for the year of displacement (t) and the year following displacement (t+1) which is the main follow-up period, and for the year before displacement (t-1) representing anticipation effects and any error in the timing of the layoff. We also report pre-sampling effects three years before the layoff (t-3) as a placebo to assess whether the parallel trend assumption is fulfilled in the CDD model we apply.[29] All the estimates reported in the figures come from separate estimations of the CDD model. The outcome variables are all defined such that a positive value suggests a deteriorated health, and around the estimated effects we show a 95 percent confidence interval.

In a first step, we look at outcomes that are largely determined by lifestyle changes and health behavior, i.e. weight, absence of regular weekly physical activity, and smoking.

[28] All estimates are also reported in Table A2 and Table A3 in the Appendix.
[29] With t-2 being the reference, positive effects in the pre-sampling period, t-3, suggest that there is a deviating trend where outcome for the matched non-treated is growing (declining) at a faster (slower) rate than for the treated. The C3D results are reported in Figure A1-Figure A4.

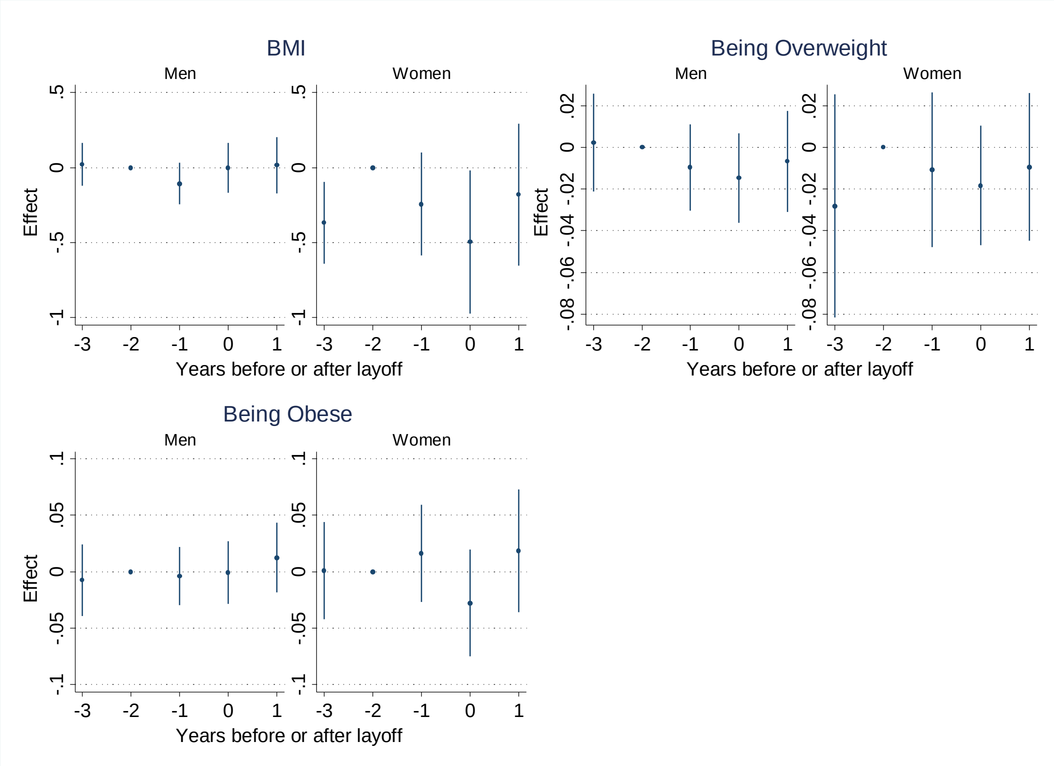


Figure 1. Effect of Being Laid off for Individuals with T2D on Weight

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on weight in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

We measure weight both as average body mass index (BMI), and at two places in the upper part of the weight distribution: being overweighed (BMI≥25) and being obese (BMI≥30). In Figure 1, we see that men with T2D do not gain weight after being laid-off: Estimates for change in the average BMI, the likelihood of being overweight or obese are all close to zero in the follow-up period (t, t+1) and not statistically significant. The estimated pre-sampling effects (t-3) are also close to zero suggesting that the parallel trend assumption is fulfilled. For women the results are more noisy and we see that the pre-sampling effects are negative for average BMI and the likelihood of being overweight (only statistically significant for BMI), which suggests that the parallel trend assumption may not be fulfilled. For the likelihood of being obese, the pre-sampling effects are close to zero also for women, but point estimates for effects at in the follow-up period are noisy (minus 2 percentage points in t and plus 2 percentage points in t+1). For men the C3D result confirm the likely absence of weight effects, for women, however, the C3D result rather point towards the loss of weight due to being laid off (Figure A1).

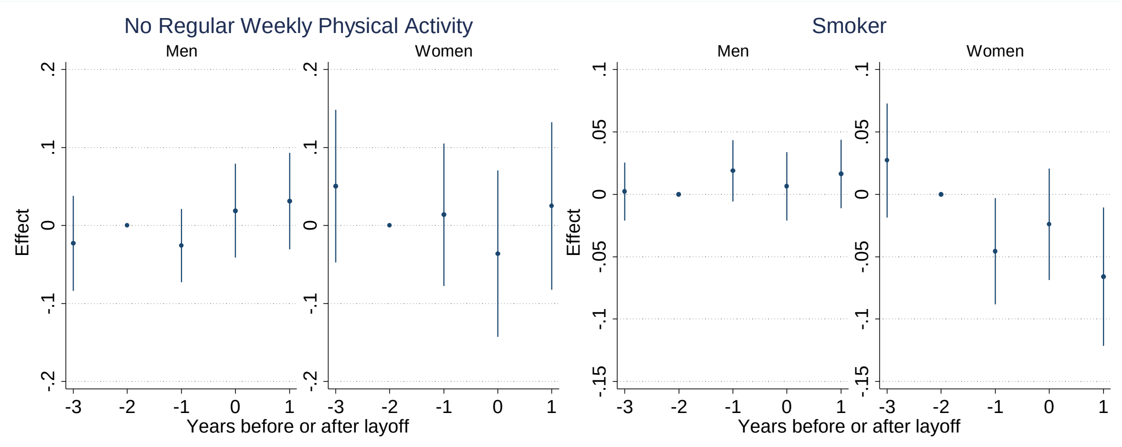


Figure 2. Effect of Being Laid off for Individuals with T2D on Behavioral Indicators

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on behavioral indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

In Figure 2 we report the impact of displacement on health-related habits like physical exercise and smoking. For men with T2D, we find no effect of being displaced on physical exercise measured as abstaining from regular weekly physical. The point estimates in the follow-up period are small and not significant. Also, the pre-sampling effect three years before the layoff is small and non-significant indicating that the parallel trend assumption is fulfilled.

For women with T2D the estimated effect of displacement on the absence of weekly physical activity is also small in the follow-up period (t, t+1), but the standard errors are larger than for men. The pre-sampling effect is, however, positive for women, albeit not significant, suggesting that there may be a change towards a more active lifestyle for displaced, relative to matched non-displaced female workers already three years before the layoff, which would bias the results downwards. In Figure A2 in the Appendix, where we try to account for the deviation from parallel trends using a C3D strategy, we consequently find more positive point estimates for women, but these effects are never statistically significant.

Smoking constitutes our third indicator for behavioral changes. Our results do not show that males with T2D are at significant higher risk of being a smoker following a layoff: The estimated effects for the follow-up period are small as is the pre-sampling effect. For females with T2D the point estimate for the pre-sampling effect is positive, and even, if it is not statistically significant, this casts doubt on the parallel trend assumption: Displaced women with T2D may have a faster decline in the likelihood of smoking than matched non-displaced workers starting with three years before the layoff.

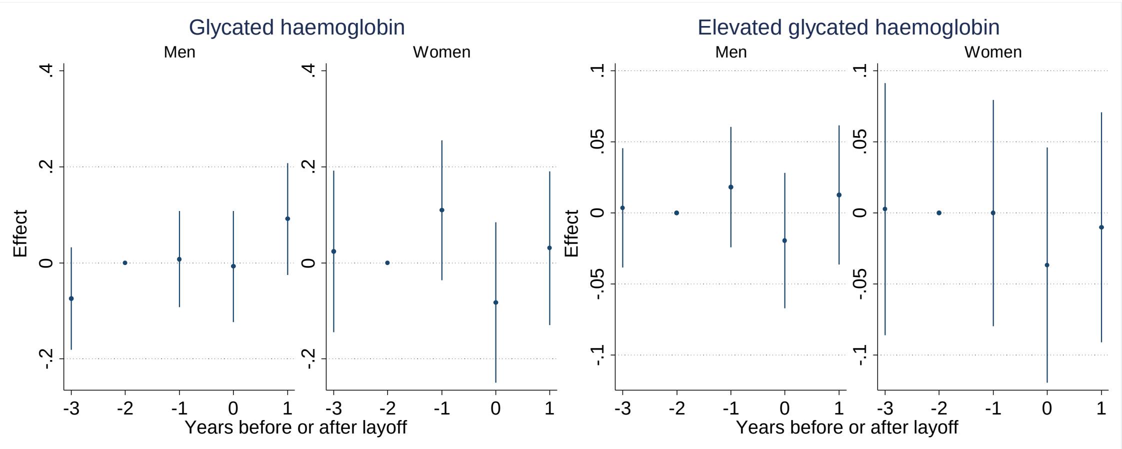


Figure 3. Effect of Being Laid off for Individuals with T2D on Progression Indicators

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on diabetes progression in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. Elevated glycated haemoglobin is defined as HbA1c ≥ 6 percent.

Next, we look at outcomes directly related to the progression of T2D and to cardiovascular co-morbidity.

In Figure 3 we investigate whether the T2D progresses by focusing on the HbA1c level. For men with T2D, being displaced does not seem to increase either the HbA1c (glycated haemoglobin) level or the likelihood of having elevated glycated haemoglobin (≥6 percent). Point estimates in the follow-up period are small and not statistically significant. However, in the analysis for level of HbA1c the point estimate for the pre-sampling effect is negative; suggesting that displaced men may have a faster deterioration of HbA1c relative to those matched non-displaced starting with three years before the layoff. When we try to account for a deviation in trend using a C3D-strategy, see Figure A3 in the Appendix, we find that the estimates in the follow-up period are further reduced and become negative, and further corroborating the notion that layoffs do not enhance the progression of T2D. For women with T2D the estimated effects of being displaced on the HbA1c level and the likelihood of having elevated glycated haemoglobin in the follow-up period are small, insignificant, and centered around zero, even if the confidence intervals are larger than for men. Also the pre-sampling effect three years before the layoff is close to zero, suggesting that the parallel trend assumption is fulfilled.

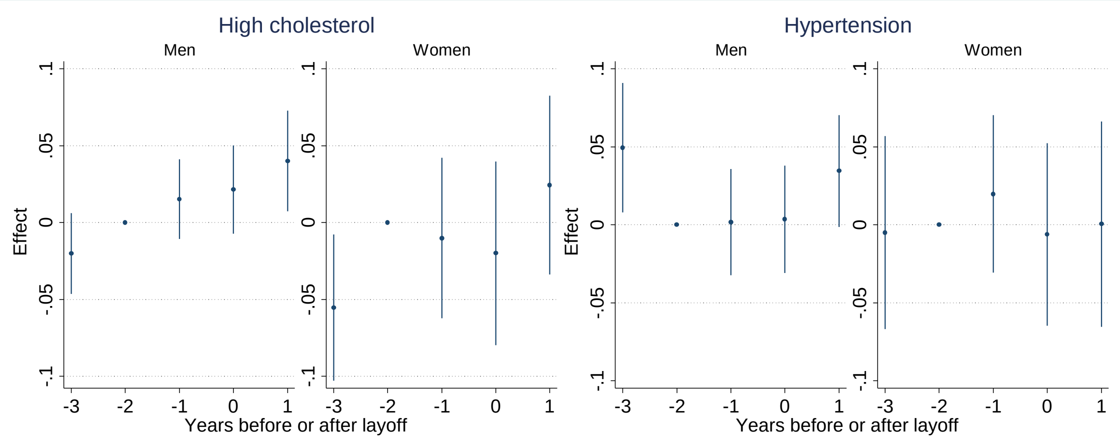


Figure 4. Effect of Being Laid off for Individuals with T2D on Cholesterol Level and Hypertension

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on cardiovascular risk indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

In Figure 4 we assess the effect of layoffs on indicators for cardiovascular risk; namely elevated cholesterol and hypertension. For both men and women with T2D we find negative pre-sampling effects for the likelihood of having high cholesterol (significant at 10 percent for man and at 5 percent for women): Displaced individuals thus appear to have a faster deterioration of cholesterol values than matched non-displaced peers three years before the layoff. The effects in the follow-up period are positive for men (statistically significant in t+1) and centered around zero for women. In Figure A4 in the Appendix, where we exploit a C3D-strategy to account for the deviating trends, the point estimates become negative in the follow-up period (significant at the 10 percent level for women).

Finally, for men with T2D we find that displacement increases the likelihood of hypertension in the follow-up period: The effect is statistically significant in t+1. However, also the pre-sampling effect is positive, and when accounting for the deviating trend with C3D, Figure A4 in the Appendix, the point estimates in the follow-up period are increased, but no longer statistically significant since the standard errors also increase. For women with T2D, on the other hand, we do not find any evidence that displacement would increase the likelihood of hypertension.

To summarize, the results do not suggest that men with T2D change lifestyle and health behavior as a consequence of being displaced in a mass layoff. We find small or negligible effects on weight, absence of regular weekly physical activity, and smoking. For women it is more difficult to draw inference since effects are less precisely estimated and the results indicate that the parallel trend assumption may not be fulfilled. Moreover, the results do not support the notion that the progression of T2D in terms of HbA1c is enhanced at displacement. The effects at displacement and the year after displacement are small and not statistically significant both for men and women, with the results for women being somewhat less precisely estimated. The results for the indicators for cardiovascular risk are more difficult to interpret since the placebo analyses suggest that there may be deviating pre-trends. When analyzing the effect of displacement on the likelihood of having high cholesterol we find that the parallel trends assumption in the CDD model is not fulfilled. When trying to adjust for the deviating trends in high cholesterol, the results suggest that the likelihood of high cholesterol does not increase as a result of being laid off. For hypertension the results suggest a positive effect for men but no effect for women.

The appraised point estimates for disease progression due to layoff are small compared to the natural progress of type 2 diabetes. The HbA1c level increases naturally by about 0.08 points (1.2 percent) yearly for the individuals with diagnosed type 2 diabetes that we sample. Similarly, the share of individuals with high cholesterol and with hypertension increases naturally by, respectively, 0.01 and 0.03 percentage points yearly in our sample. From this perspective the estimated insignificant effects of displacement are small.

4.2 Mechanisms

To gain additional understanding of the underlying mechanisms behind the baseline results, we report the effect of being displaced through mass layoff on re-employment and earnings, as well as heterogeneous effects of health behavior, diabetes progression and cardiovascular co-morbidity with respect to re-employment, workplace tenure and age. We only analyze heterogeneous effects for men, because the sample of displaced women is too small for subgroup analyses.

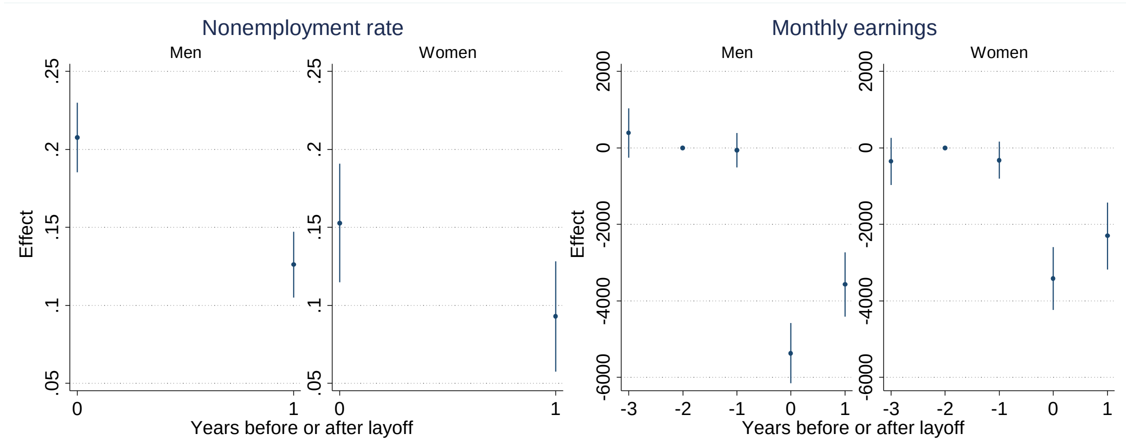


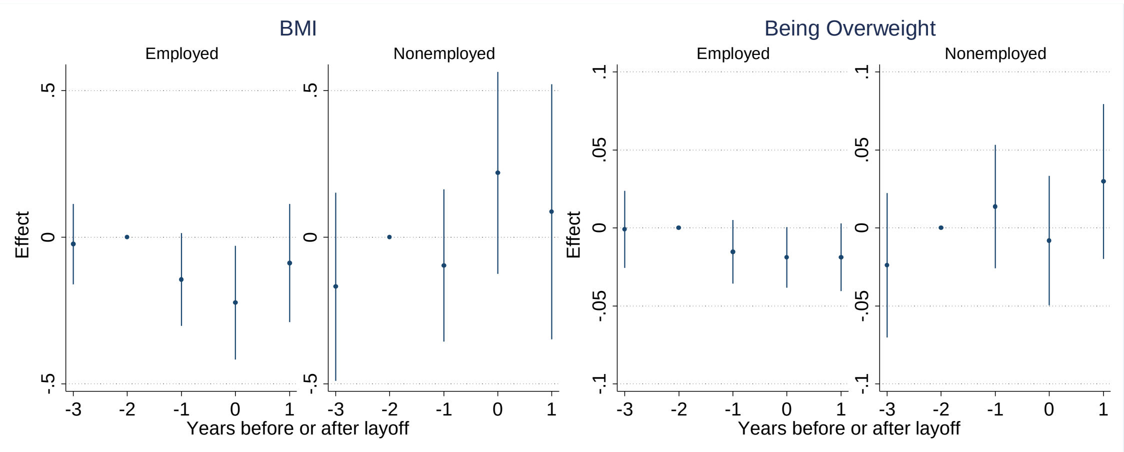
Figure 5. Effect of Being Laid off for Individuals with T2D on Non-employment and Earnings

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on non-employment and wage earnings in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

One way to understand the small effects of displacement on lifestyle factors and diabetes progression is if workers are re-employed on similar terms relatively fast. That is, if being laid off does not seriously affect individuals' economic and psychosocial situation. In Figure 5 we see that being displaced increases the likelihood of non-employment in the year of the layoff with 20 percentage points for men with T2D and 15 percentage points for women with T2D. The effect is falling back to 13 (9) percentage points for men (women) in the year following the mass layoff (t+1).[30] Displacement also reduces monthly earnings by an average of 5500 SEK for men and 3500 SEK for women in the year of the layoff, which constitute 22 and 19 percent of

[30] Non-employment is defined as calculated December earning less than the minimum wage.

the pre-displacement earnings, respectively. In the following year the earnings loss is reduced to about 13 percent for both men and women. Even if there is a substantial reduction of employment and earnings for individuals with T2D, the results show that a job loss does not necessarily lead to unemployment. A relatively large share of displaced workers are gainfully re-employed 1–2 years after being laid off, where the relatively long notice time and ALMP may contribute to the fast recovery from displacement in Sweden. Eliason and Storrie (2004, 2006) find similar results for Swedish workers aged 41–50: Employment is reduced by 10 percentage points at displacement and by 4 percentage points the following year, for workers aged 41–50. Note that our sample is older (40–60 years) and constitutes a vulnerable labor market group due to their illness. The effects of job loss even for the general population are substantially larger in the US: Earnings reductions for workers displaced through mass layoff range 32–40 percent in the period immediately following job-loss, with sustained earnings losses of 13–25 percent up to 6 years after displacement (see Jacobson, LaLonde and Sullivan 1993; Couch and Placzek 2010).



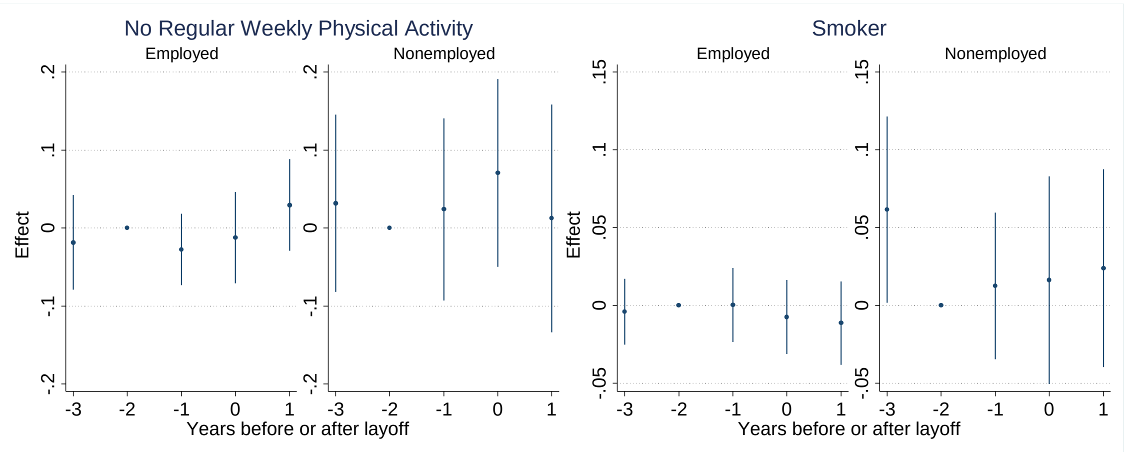


Figure 6. Effect of Being Laid off for Individuals with T2D on Behavioral Indicators: Re-employed versus non-employed

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on behavioral indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Heterogenous effects with respect to employment. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

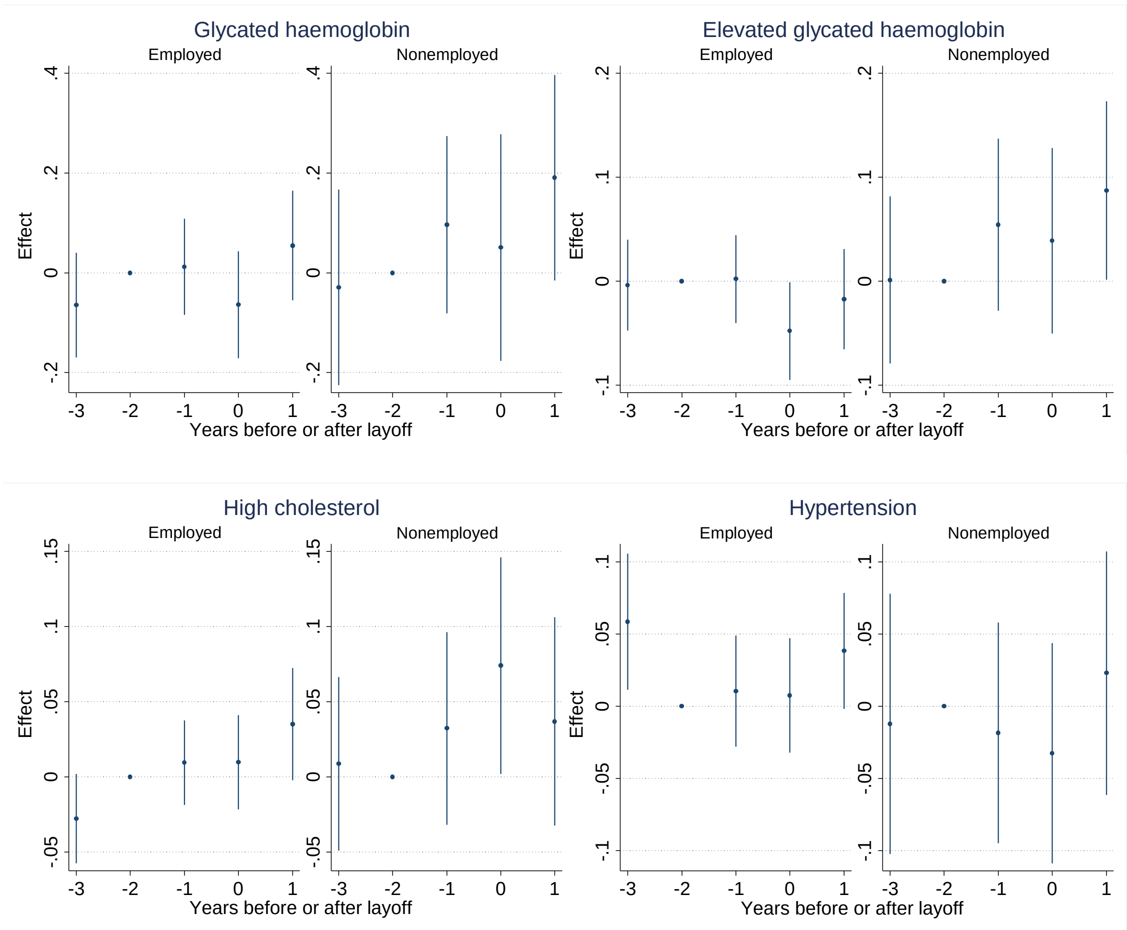


Figure 7. Effect of Being Laid off for Individuals with T2D on diabetes progression and cardiovascular co-morbidity: Re-employed versus non-employed

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on diabetes progression and cardiovascular risk indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Heterogenous effects with respect to employment. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

We also analyze if there are heterogeneities in health behavior, diabetes progression and cardiovascular co-morbidity between men with T2D who are re-employed and non-employed following the job loss. Even if employment status is endogenous with respect to health behavior, diabetes progression and cardiovascular co-morbidity the analysis is indicative of potential pathways. In Figure 6 we find suggestive evidence that the effects of displacement are larger for those individuals who do not find a job after displacement. With respect to weight we even find that those who are successfully reemployed lose weight due to the displacement. Figure 7, focusing on diabetes progression and cardiovascular co-morbidity, shows a similar picture. It suggests that displacement leads to higher HbA1c among men who remain non-employed. In the years following displacement we find positive effects (significant at 10 percent) for both average HbA1c and the likelihood of having elevated glycated haemoglobin. For the cardiovascular risk factors, on the other hand, it is difficult to see any clear pattern. The likelihood of having high cholesterol is positive and significant for non-employed in the year of displacement where, interestingly, hypertension seems to increase for those that find employment (a result that would also stay if taking the potential pretrend into account).

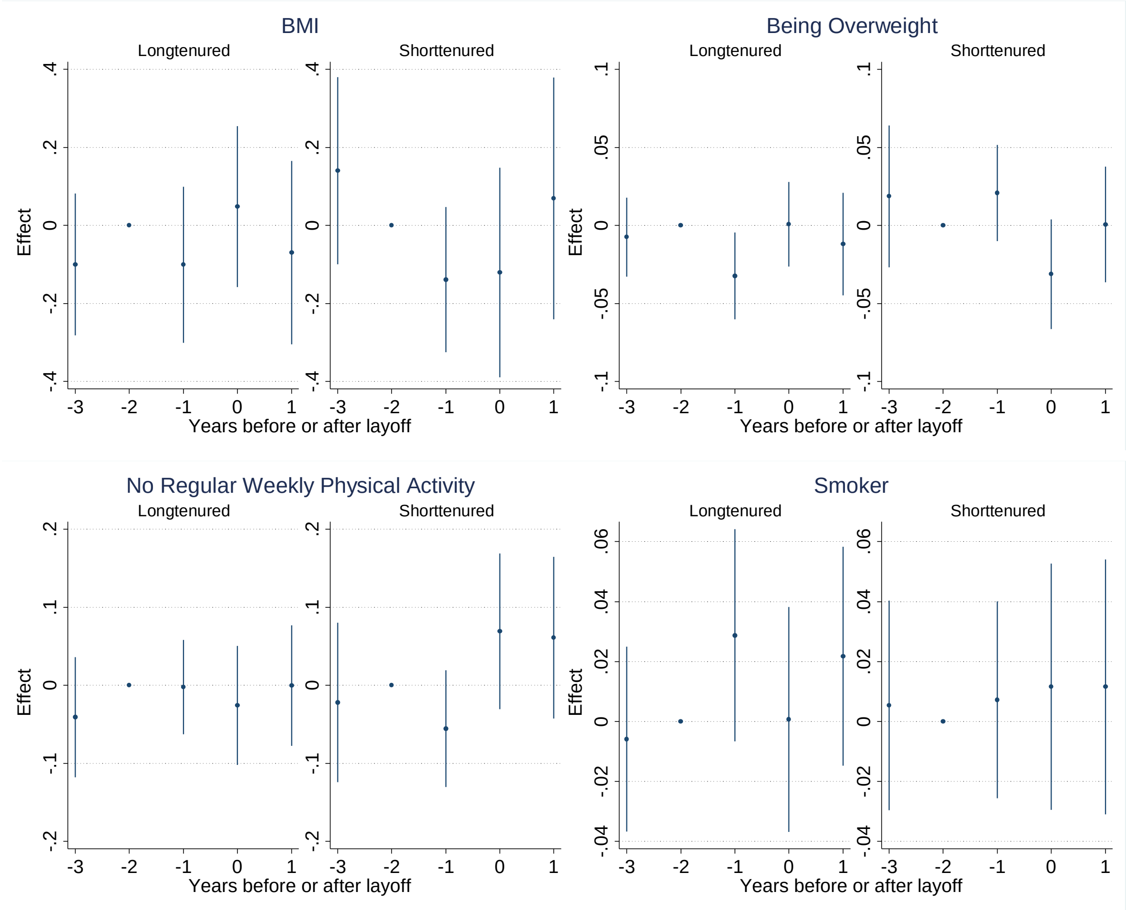


Figure 8. Effect of Being Laid off for Individuals with T2D on Behavioral Indicators: long vs. short tenure

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on behavioral indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Heterogenous effects with respect to tenure (long tenure>3 years). Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

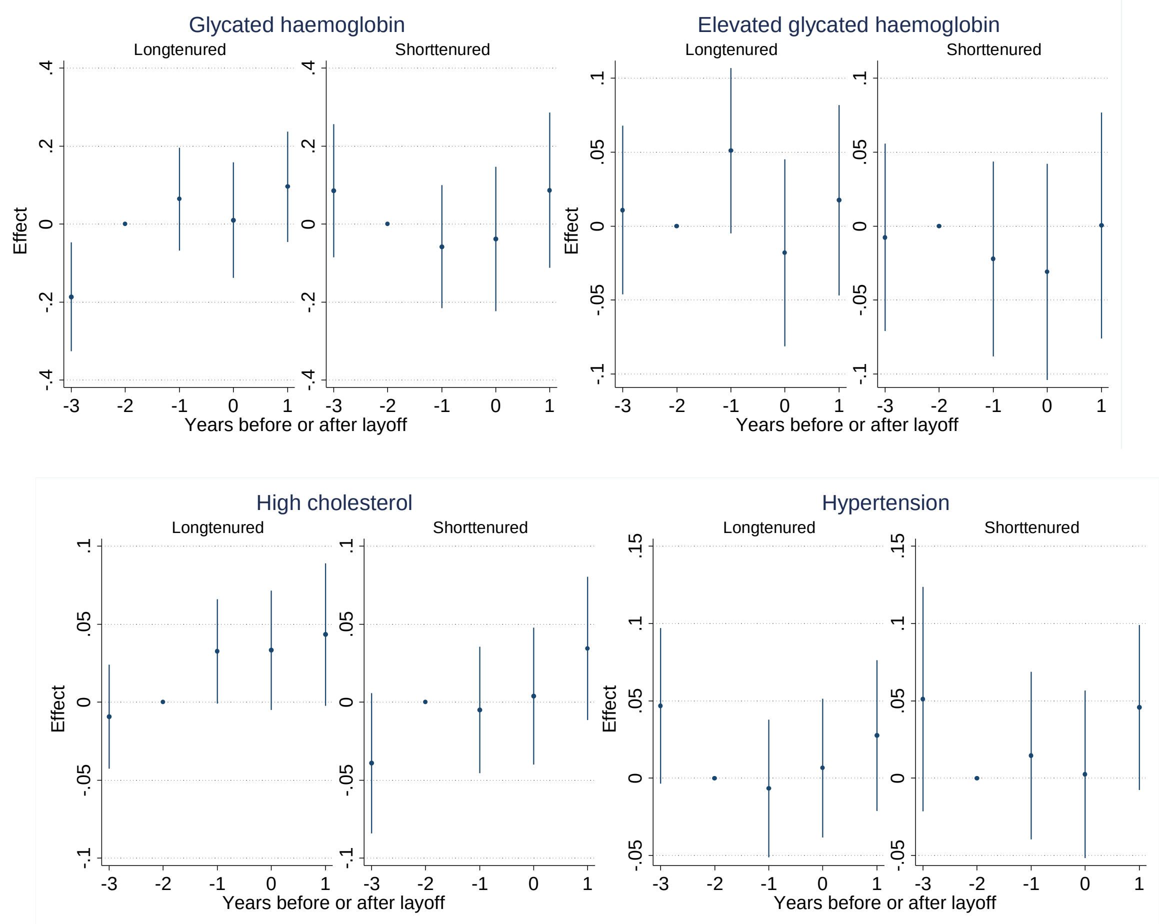


Figure 9. Effect of Being Laid off for Individuals with T2D on diabetes progression and cardiovascular co-morbidity: long versus short tenure.

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on diabetes progression and cardiovascular risk indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Heterogenous effects with respect to tenure (long tenure>3 years). Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

We next analyze if there are heterogeneities with respect to workplace tenure for men with T2D. The notion being that job loss is more of a shock, and requires more adjustment, for long tenured workers. Long tenure presumably builds more firm and job specific human capital, which makes it more difficult to find an equivalent job. Long tenured workers may thus lack skills demanded by new employers. In Figure 8 we find no evidence that the effect of displacement on health behavior is larger for long tenured workers, where long tenure is defined by being at the same workplace for 4 years or more. Similarly, in Figure 9 we find no difference for the effect on diabetes progression or hypertension between workers with long and short tenure. For cholesterol, however, we find that tenure may play a role. The results show an increase in the likelihood of having high cholesterol (statistically significant) for workers with long tenure already in the year before the mass layoff (t-1). For short tenured workers we find no effect.

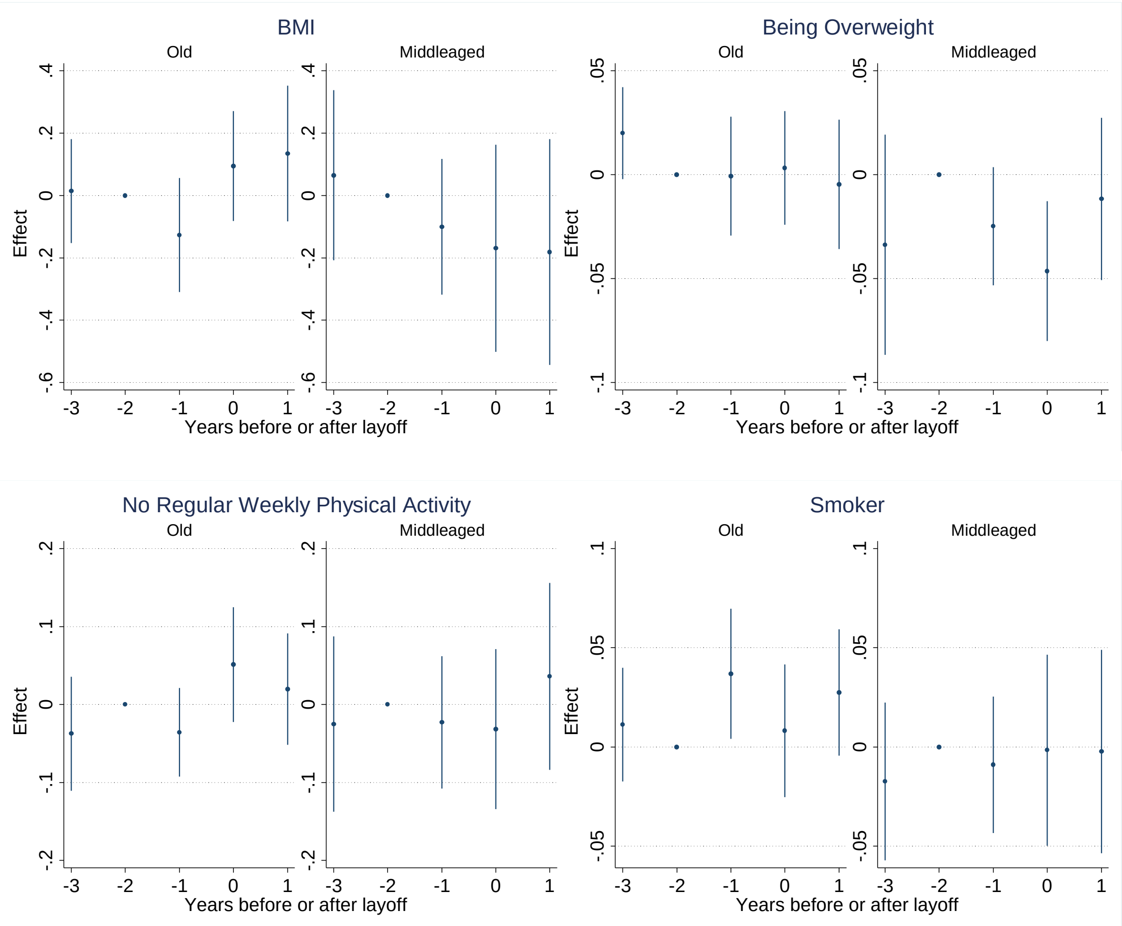


Figure 10. Effect of Being Laid off for Individuals with T2D on Behavioral Indicators: old vs. middle aged.

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on behavioral indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Heterogenous effects with respect to age (old>52). Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

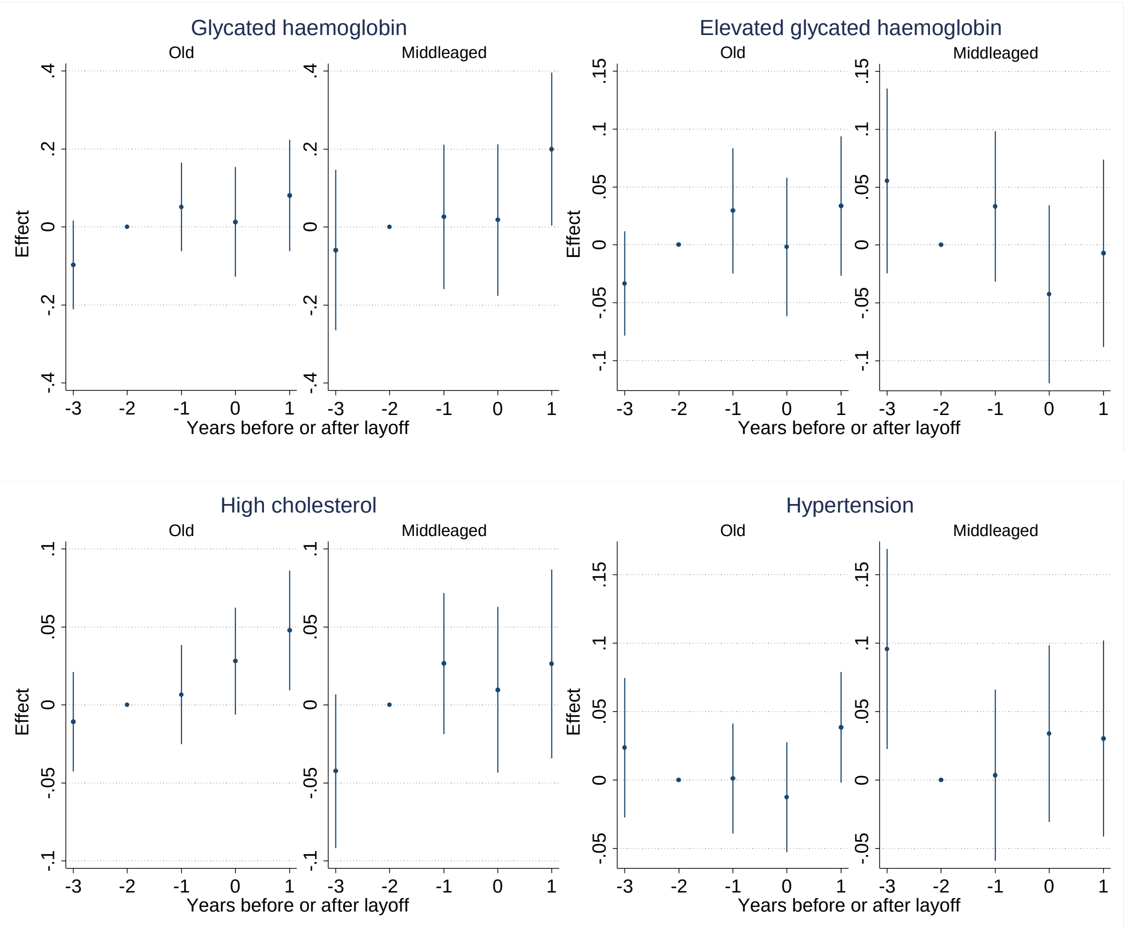


Figure 11. Effect of Being Laid off for Individuals with T2D on diabetes progression and cardiovascular co-morbidity: Old versus middle aged

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on diabetes progression and cardiovascular risk indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Heterogenous effects with respect to age (old>52). Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences were treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

Finally, we look at heterogeneities regarding age. The consequences of job loss can be different for older workers; both because older workers generally have more dated formal education and less human capital in demand by alternative employers, and because their diabetes may have progressed to a worse state potentially making them more vulnerable to additional shocks. In Figure 10 and Figure 11 where we compare effects for old (53–60) and middle aged (40–52) men with T2D we only find clear deviating patterns for smoking and cholesterol: For old workers there is an increased likelihood of smoking and having high cholesterol in the follow-up period as a result of being displaced. For middle aged workers we find no effect.

To summarize, there is a reduction of employment and earnings following job loss for individuals with T2D, but the economic consequences of job loss is considerably smaller than in a US context. We find that that a large group of displaced workers find gainful employment within 1–2 years of the mass layoff, although individuals with T2D may be a more vulnerable labor market group due to their health status. We also find indications that the blood glucose level is increased following displacement for workers who are non-employed one year after the layoff, and that there may be an increased risk for high cholesterol for older and long tenured men with T2D following displacement. Reemployed men with T2D might even lose weight but suffer from higher blood pressure.

4.3 Sensitivity analyses

In the analysis we define a mass layoff at a workplace as a reduction of at least 30 percent. This was based on a trade-off balancing the need of a sufficiently large cutback limiting employers' ability to selectively displace workers with low health, with a need of a sufficiently large number of mass laid off T2D patients. Even if von Wachter (2010) notes that the literature has settled around the 30 percent definition it entails a degree of arbitrariness, influencing which workers are laid off and the type of event they are subjected to. To test how sensitive our results are to our definition of mass layoff we have therefore re-estimated the analysis letting cutbacks of at least 45 percent constitute a mass-layoff, see Figure A5–Figure A8 in the Appendix. This reduces the number of individuals with T2D who identified as displaced due to a mass layoff by about 40 percent. The results from this sensitivity analysis are similar to the baseline results, but with larger standard errors

When analyzing the effects of displacement there is always a risk that the results are biased by endogenous anticipation effects; e.g. that individuals with favorable health and human capital, and with good alternatives on the labor market leave the workplace preemptively. In part, we address this by sampling individuals 2 years before the potential layoff; i.e. before information about cutbacks becomes available through advance notices to affected employees and pre-notification to the Public Employment Services. Workers may also infer upcoming cutbacks from firms' historical performance. In the analysis we therefore restrict attention to stable workplaces that have not experienced cutbacks larger than 30 percent during the two years preceding the potential layoff. As a sensitivity analysis we have re-estimated the analysis for the sample of workplaces not having experienced any reduction larger than 15 percent the two preceding years, see Figure A9–Figure A12 in the Appendix. This reduces the sample by about 20 percent of the workplaces. The results are essentially unchanged, but with larger standard errors, when using this more restrictive sample of workplaces. This suggests that any deviation from the parallel trends assumption observed in the baseline analysis is not likely a consequence of anticipation three years before that layoff.

Figure A13-Figure A16 display the estimated effect when we reduce the control group randomly to 25 percent, in order to avoid potential problems with sampling control group members more than once (see section 3.3). Our estimates and confidence intervals remain basically identical compared to our baseline results.

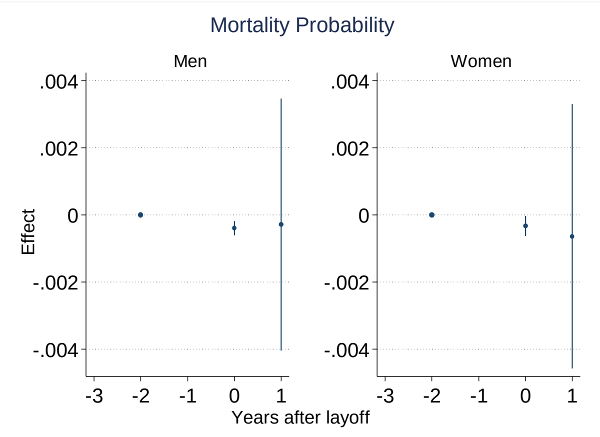


Figure 12 Effect of Being Laid off for Individuals with T2D on mortality

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on mortality in t-3, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

A potential source of bias for the analysis is if there is selective attrition out from NDR due to deteriorated health status, where this deterioration differs between displaced and non-displaced individuals. To assess whether attrition may be a problem we, in Figure 12, estimate the effect of displacement on the probability of mortality. We find no significant effect and the point estimate is very small and negative in the year following the mass-layoff.

5 Conclusion

The risk of deteriorated health adds to the welfare costs of job displacement. Can these costs be reduced by policy? In this study we use unique longitudinal data from the Swedish National Diabetes Register linked with matched employer-employee data, to analyze the health effect of job loss for a particularly vulnerable group of individuals, i.e. T2D patients. Overall the analysis gives limited support for job loss having an impact on health behavior, on diabetes progression, and on cardiovascular risk factors. We find small or negligible effects of job loss on changes in BMI, physical activity, and smoking for men with T2D, while results are more inconclusive for women. For both men and women, we find on average limited evidence that HbA1c would be increased by displacement, but for men with T2D who remain non-employed results indicate higher blood glucose levels following job loss. The results for cardiovascular risk indicators are more difficult to interpret since the parallel trends assumption may not be fulfilled, but when accounting for deviating trends the likelihood of high cholesterol does not increase with job loss, and for hypertension the results suggest an increasing effect for men but no effect for women. It should be noted that any anticipation effects would bias negative health effects towards zero.

We also find that one year after displacement the increased risk for individuals with T2D of being non-employed is 13 percentage points for men and 9 percentage points for women, and that the average loss in wage earnings is about 13 percent.

This suggests that there may by scope to limit, or cancel out, the negative health consequences of job displacement with comprehensive unemployment insurance and ALMP that limit the economic consequences of job loss, with universal health insurance, and by monitoring health of displaced workers, even for groups of individuals whose background health make them highly vulnerable to labor market shocks. Even if the small sample size precludes us from ruling out moderate effects, the apprised point estimates for disease progression is small relative to the natural progression of the disease.

Our study implies that a fruitful line of future research is to explore the role of the institutional setting and how men and women may be differently affected by job loss.

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Appendix: Supplementary results

Table A1. Exemplary Probit Estimation used in the IPW Approach for Outcome 'No Regular Physical Activity at time of Layoff'

	Men	Women
Diabetes since ≤5 years	0.0933	0.0674
	(0.77)	(0.33)
Recentered Age	-0.0135	0.0144
	(-0.55)	(0.34)
Rec. Age, Squared	0.0000465	-0.00123
	(0.05)	(-0.71)
Rec. Years of Education	-0.00471	0.0971
	(-0.12)	(1.03)
Rec. Years of Education, Squared	-0.00253	-0.00903
	(-0.56)	(-0.95)
Firm Size		
101 – 500	-0.124*	-0.0139
	(-1.98)	(-0.13)
> 500	-0.297***	-0.549**
	(-3.42)	(-3.03)
Industry		
Manufacturing	0.155	0.324
	(1.76)	(1.54)
Utilities and construction	0.483***	0.0843
	(4.70)	(0.32)
Information, financial and real estate services	-0.137	0.191
	(-1.19)	(0.78)
Professional and admin. Services	0.213*	-0.0696
	(2.11)	(-0.33)
Arts, Public, education, health and other services	-0.198	-0.0405
	(-1.34)	(-0.19)
Family Status		
Married or cohab., no children	-0.0506	0.242
	(-0.58)	(1.60)
Married or cohab., child < 18	-0.167	0.00758
	(-1.87)	(0.04)
Single	-0.156	0.219
	(-1.89)	(1.39)
Single, child	-0.0569	0.0267
	(-0.48)	(0.13)
Previous montly wage		
10,000 ≤ x < 15,000	0.208	-0.239
	(1.86)	(-1.46)
15,000 ≤ x < 20,000	0.0457	-0.123
	(0.66)	(-1.02)
25,000 ≤ x < 30,000	-0.0597	0.0741
	(-0.74)	(0.41)
30,000 ≤ x < 40,000	-0.290**	
	(-2.69)	
≥ 30,000		-0.299
		(-1.26)
≥ 40,000	0.0200	
	(0.15)	
Private firm	0.258**	0.280
	(2.59)	(1.92)
White collar worker	-0.0588	0.154
	(-0.97)	(1.24)
Tenure with firm, years	-0.104*	-0.129
	(-2.04)	(-1.52)
Tenure with firm, years, squared	0.0115	0.0152
	(1.95)	(1.54)
≥ 10 years with firm	-0.127	-0.325
	(-0.65)	(-0.92)
Tenure with firm * diabetes ≤ 5	-0.0504	0.0494
	(-0.67)	(0.41)
Tenure with firm, squared * diabetes ≤ 5	0.00512	-0.00635
	(0.58)	(-0.44)
Tenure >10 * diabetes ≤ 5	-0.282	-0.0651

	(-0.93)	(-0.12)
2 – 3 year old firm	0.320***	-0.00486
	(3.32)	(-0.03)
≥ 10 year old firm	0.0171	-0.198
	(0.24)	(-1.68)
Ln of sick days, previous year	-0.0140	-0.0432
	(-0.66)	(-1.25)
Ln of sick days, 2 year previous	-0.0155	-0.0158
	(-0.74)	(-0.47)
Ln of sick days, 3 years previous	0.0195	-0.00493
	(1.02)	(-0.16)
Ln of hospital days, previous 3 years	0.0332	0.341
	(0.33)	(1.68)
Ln of hospital days, 4-6 years previous	0.0324	-0.623*
	(0.31)	(-2.05)
Ln of episodes in hospital , previous 3 years	-0.106	-0.532
	(-0.60)	(-1.43)
Ln of episodes in hospital, 4-6 years previous	-0.199	0.823*
	(-1.07)	(2.13)
Ln of hos. Days 3 years * tenure < 3 years	0.0509	-0.0338
	(0.66)	(-0.23)
Ln of hos. Days 3 years * 3≤tenure≤6 years	0.0171	-0.109
	(0.16)	(-0.55)
Ln of hos. Days 4-6 years * tenure < 3 years	0.0553	0.188
	(0.65)	(0.86)
Ln of hos. Days 4-6 years * 3≤tenure≤6 years	0.0605	0.219
	(0.55)	(0.83)
Family member with diabetes	-0.0905	-0.146
	(-1.59)	(-1.44)
Vacancy-unemployment ratio	0.106	-0.126
	(1.22)	(-1.19)
< 7.4% diabetes rate in country of origin	-0.0472	-0.130
	(-0.56)	(-0.89)
Urban	0.159**	0.160
	(2.83)	(1.59)
Potential layoff in 2008/2009		0.246
		(1.92)
Potential layoff in 2006	0.492*	
	(2.06)	
Potential layoff in 2008	0.445***	
	(4.64)	
Potential layoff in 2009	0.716***	
	(6.33)	
Constant	-2.087***	-2.192***
	(-7.88)	(-4.53)
Observations	8064	4392

Note: Probit estimates of the propensity for the sample of individuals with valid observations on “No regular weekly physical activity in year of potential layoff”. Student’s t in the parentheses. *,**,*** stands for statistical significance at the 10%, 5% and 1% level.

Table A2. Baseline Estimation Results for Men

	Years after layoff			
	-3	-1	0	1
Outcome variable	Effect/StdErr	Effect/StdErr	Effect/StdErr	Effect/StdErr
BMI	0.0209	-0.1058	-0.0007	0.0158
	(0.0730)	(0.0713)	(0.0847)	(0.0964)
N-Obs Untreated	8168	11602	11725	11694
N-Obs Treated	356	478	472	469
Being Overweight	0.0022	-0.0096	-0.0147	-0.0068
	(0.0120)	(0.0106)	(0.0109)	(0.0123)
N-Obs Untreated	8168	11602	11725	11694
N-Obs Treated	356	478	472	469
Being Obese	-0.0076	-0.0041	-0.0010	0.0125
	(0.0162)	(0.0132)	(0.0141)	(0.0158)
N-Obs Untreated	8168	11602	11725	11694
N-Obs Treated	356	478	472	469
No Regular Weekly Physical	-0.0227	-0.0259	0.0190	0.0312
Activity	(0.0311)	(0.0240)	(0.0307)	(0.0315)
N-Obs Untreated	4050	7656	7728	7631
N-Obs Treated	237	334	336	348
Smoker	0.0023	0.0189	0.0064	0.0164
	(0.0118)	(0.0125)	(0.0140)	(0.0140)
N-Obs Untreated	7480	10546	10581	10519
N-Obs Treated	325	424	420	441
Glycated Haemoglobin	-0.0743	0.0079	-0.0076	0.0915
	(0.0544)	(0.0513)	(0.0589)	(0.0594)
N-Obs Untreated	8823	12671	12977	13013
N-Obs Treated	391	520	524	536
Elevated Glycated Haemoglobin	0.0035	0.0182	-0.0195	0.0126
	(0.0214)	(0.0216)	(0.0243)	(0.0250)
N-Obs Untreated	8823	12671	12977	13013
N-Obs Treated	391	520	524	536
High cholesterol	-0.0201	0.0152	0.0216	0.0401
	(0.0134)	(0.0132)	(0.0147)	(0.0167)
N-Obs Untreated	7036	10123	10299	10406
N-Obs Treated	309	433	430	443
Hypertension	0.0495	0.0018	0.0036	0.0345
	(0.0212)	(0.0174)	(0.0175)	(0.0183)
N-Obs Untreated	8368	11956	12278	12346
N-Obs Treated	361	489	498	513

Table A3. Baseline Estimation Results for Women

	Years after layoff			
	-3	-1	0	1
Outcome variable	Effect/StdErr	Effect/StdErr	Effect/StdErr	Effect/StdErr
BMI	-0.3690	-0.2424	-0.4958	-0.1793
	(0.1390)	(0.1747)	(0.2435)	(0.2414)
N-Obs Untreated	4571	6398	6400	6400
N-Obs Treated	99	154	146	145
Overweight	-0.0281	-0.0108	-0.0184	-0.0094
	(0.0274)	(0.0189)	(0.0146)	(0.0181)
N-Obs Untreated	4571	6398	6400	6400
N-Obs Treated	99	154	146	145
Obese	0.0007	0.0161	-0.0279	0.0185
	(0.0220)	(0.0220)	(0.0241)	(0.0278)
N-Obs Untreated	4571	6398	6400	6400
N-Obs Treated	99	154	146	145
No Regular Weekly Physical	0.0505	0.0139	-0.0362	0.0249
Activity	(0.0500)	(0.0465)	(0.0545)	(0.0548)
N-Obs Untreated	2313	4213	4303	4209
N-Obs Treated	53	88	89	94
Smoker	0.0272	-0.0456	-0.0240	-0.0661
	(0.0233)	(0.0217)	(0.0227)	(0.0283)
N-Obs Untreated	4318	6019	5978	6008
N-Obs Treated	99	141	136	135
Glycated Haemoglobin	0.0241	0.1096	-0.0828	0.0305
	(0.0859)	(0.0744)	(0.0853)	(0.0817)
N-Obs Untreated	5006	7104	7270	7355
N-Obs Treated	110	166	164	169
Elevated Glycated Haemoglobin	0.0027	-0.0001	-0.0368	-0.0102
	(0.0453)	(0.0406)	(0.0423)	(0.0413)
N-Obs Untreated	5006	7104	7270	7355
N-Obs Treated	110	166	164	169
High cholesterol	-0.0553	-0.0101	-0.0199	0.0244
	(0.0243)	(0.0266)	(0.0305)	(0.0296)
N-Obs Untreated	3888	5514	5642	5720
N-Obs Treated	93	128	129	133
Hypertension	-0.0050	0.0198	-0.0061	0.0005
	(0.0315)	(0.0258)	(0.0298)	(0.0336)
N-Obs Untreated	4708	6627	6746	6840
N-Obs Treated	102	155	155	154

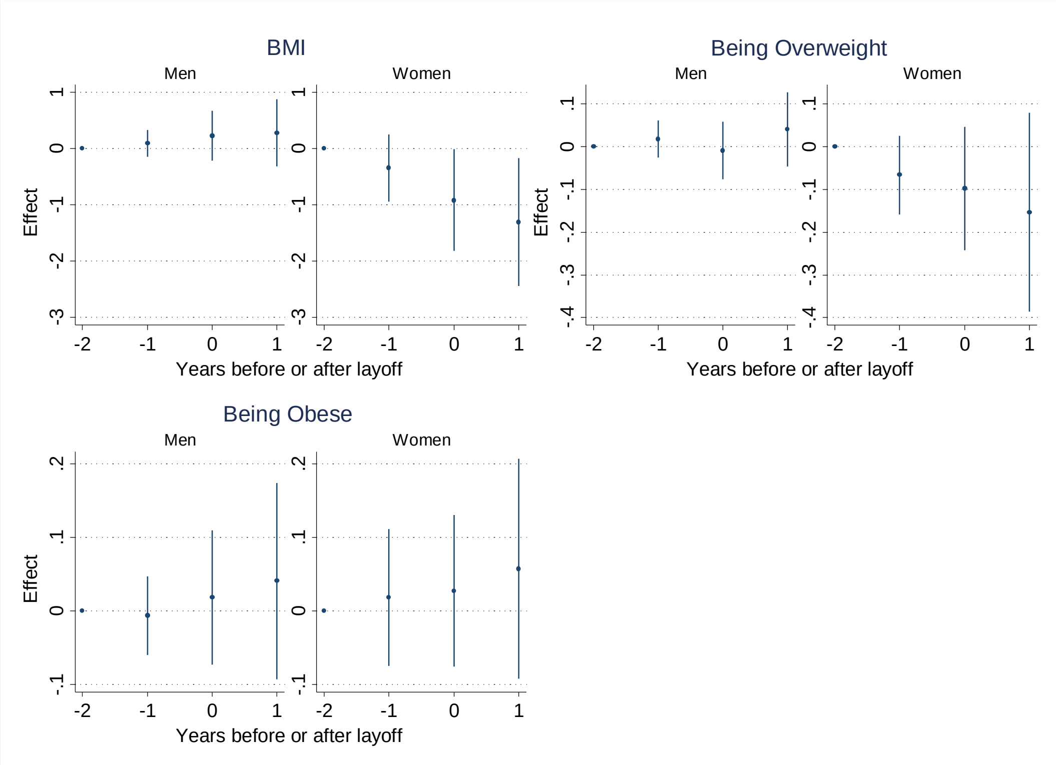

Figure A1. Effect of being Laid off for Individuals with T2D on Weight estimated with C3D

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on weight in t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Triple-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

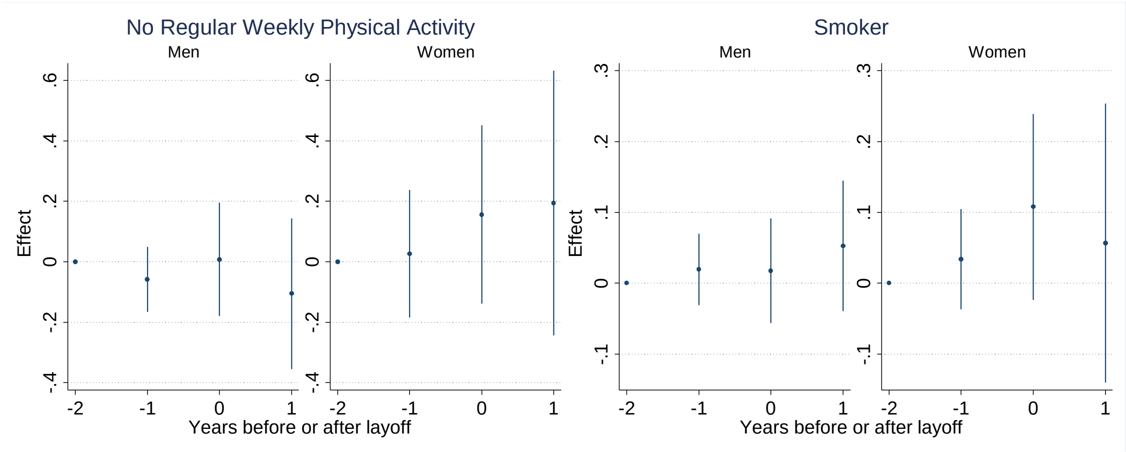

Figure A2. Effect of being Laid off for Individuals with T2D on Behavioral Indicators estimated with C3D

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on behavioral indicators in t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Triple-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

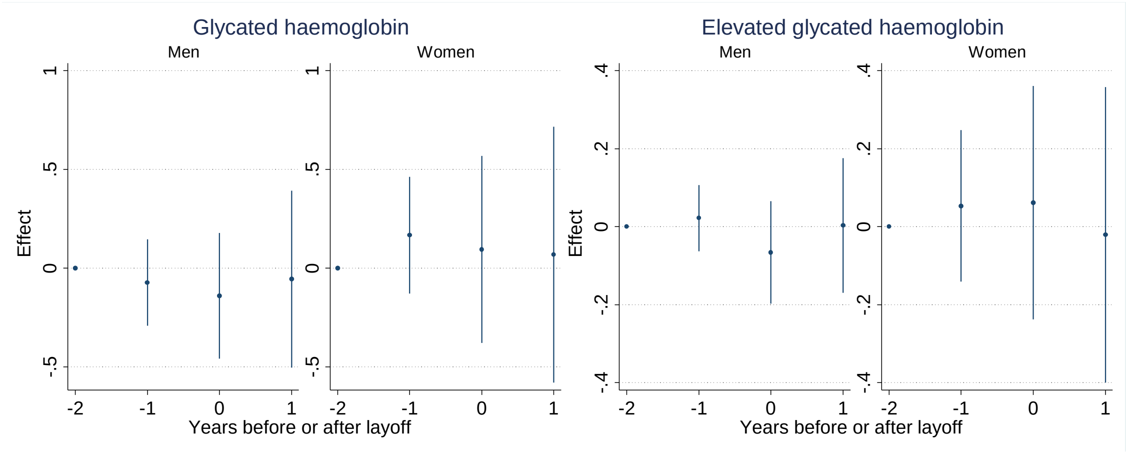

Figure A3. Effect of being Laid off for Individuals with T2D on Progression Indicators estimated with C3D

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on diabetes progression in t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Triple-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

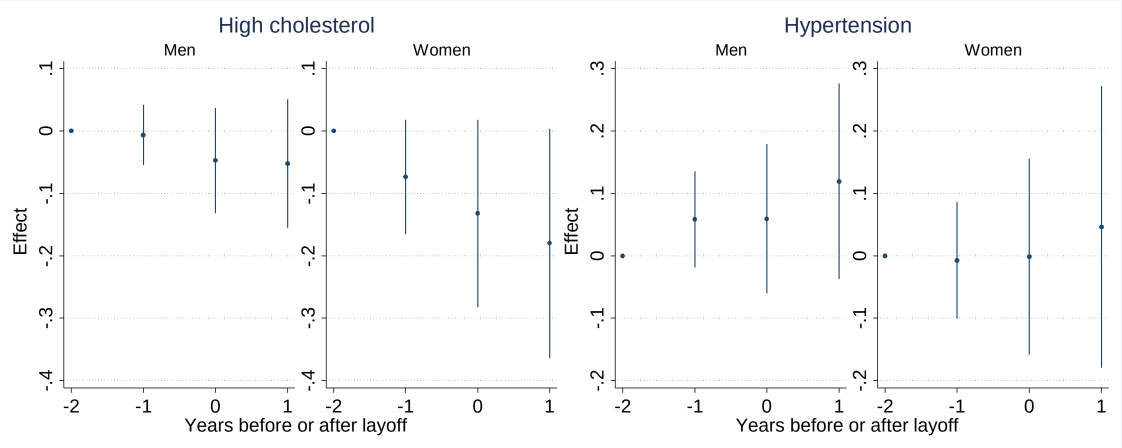

Figure A4. Effect of being Laid off for Individuals with T2D on Cholesterol Level and Hypertension estimated with C3D

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on cardiovascular risk indicators in t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Triple-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

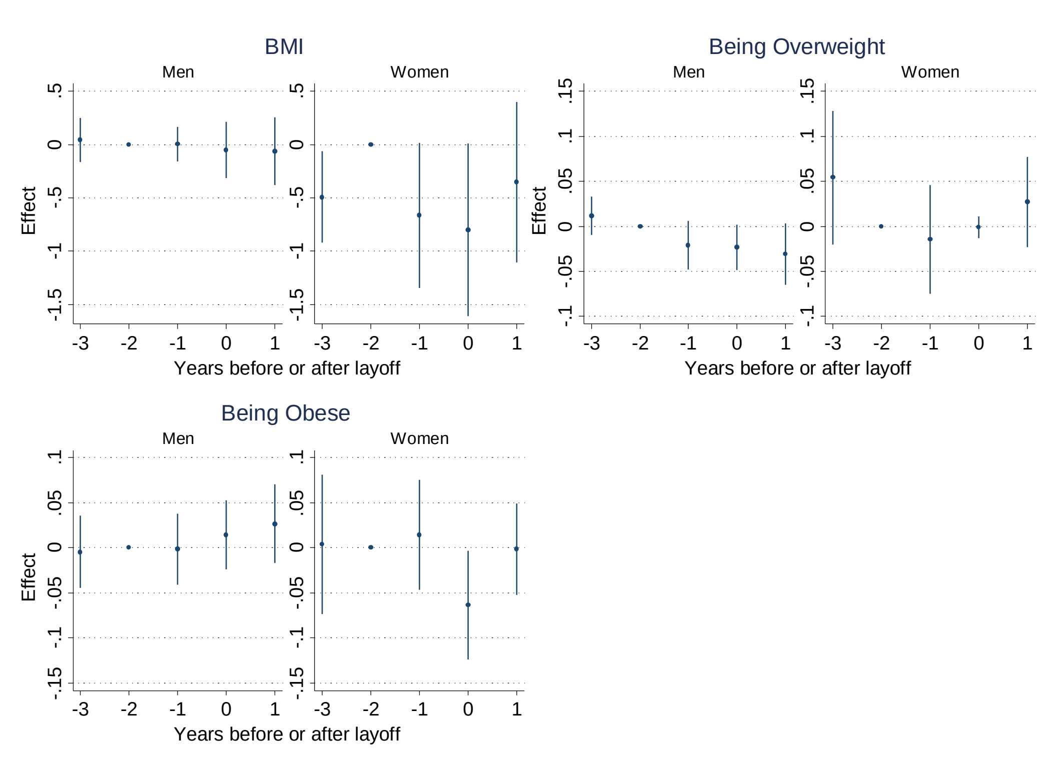

Figure A5. Effect of being Laid off for Individuals with T2D on Weight using the 45 percent definition for mass-layoffs

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on weight in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 45 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

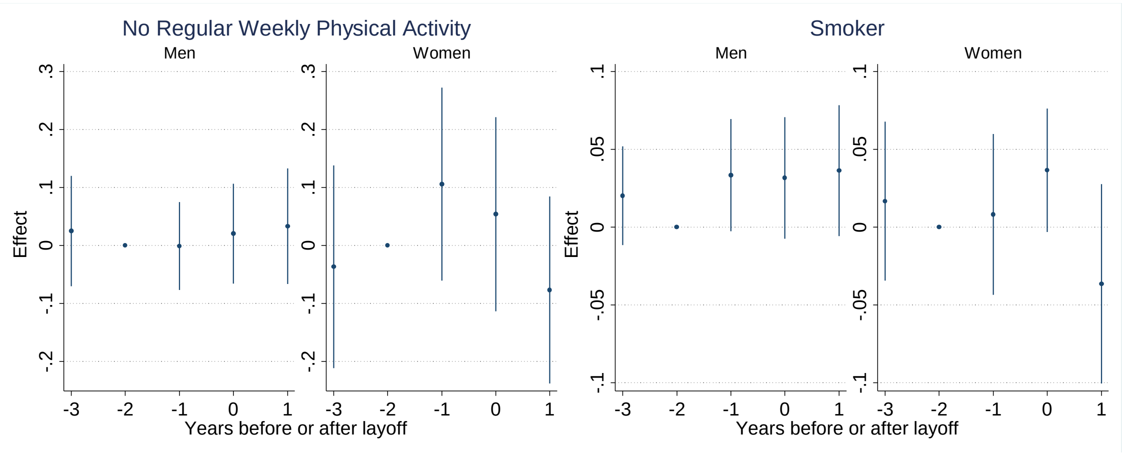

Figure A6. Effect of being Laid off for Individuals with T2D on Behavioral Indicators using the 45 percent definition for mass-layoffs

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on behavioral risk indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 45 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

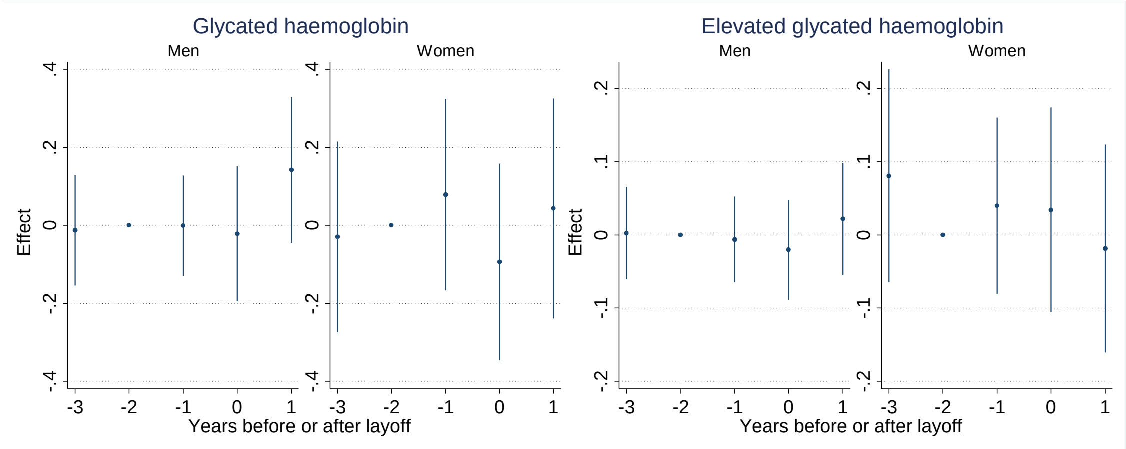

Figure A7. Effect of being Laid off for Individuals with T2D on Progression Indicators using the 45 percent definition for mass-layoffs

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on diabetes progression in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 45 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

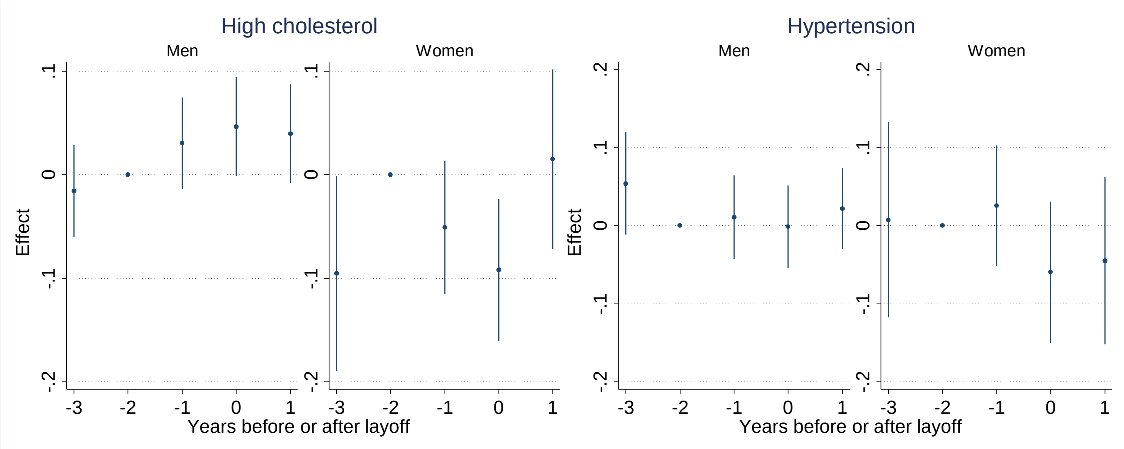

Figure A8. Effect of being Laid off for Individuals with T2D on Cholesterol Level and Hypertension using the 45 percent definition for mass-layoffs

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on cardiovascular risk indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 45 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator.

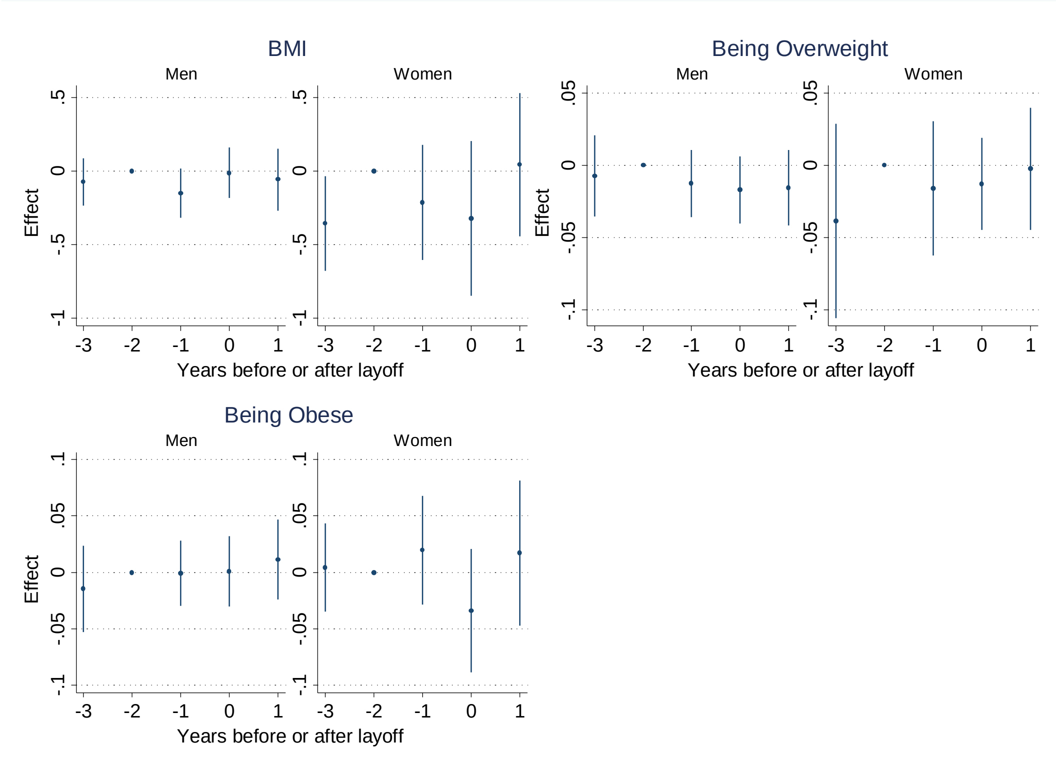

Figure A9. Effect of being Laid off for Individuals with T2D on Weight for stable workplaces (15 percent)

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on weight in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. The sample of workplaces have not experienced any reduction larger than 15 percent between any of the two years preceding the potential layoff.

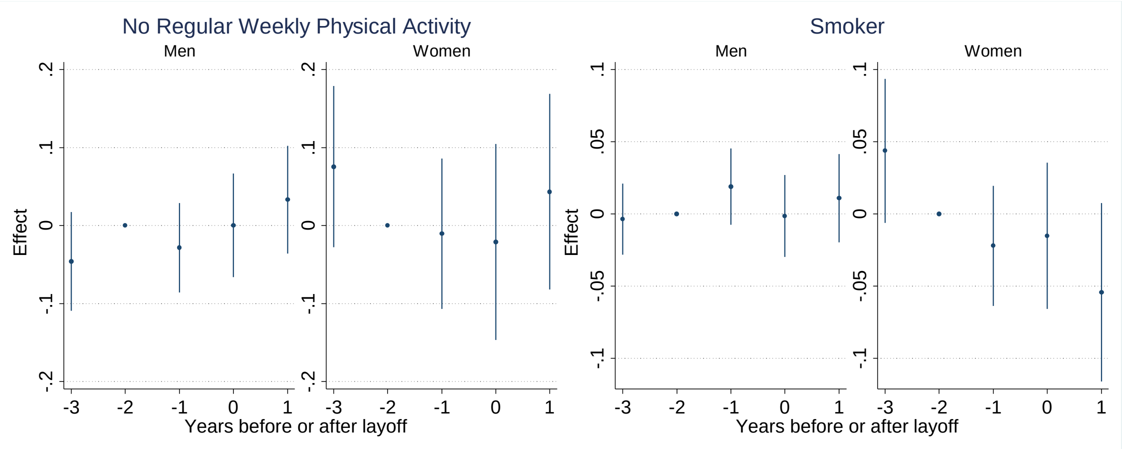

Figure A10. Effect of being Laid off for Individuals with T2D on Behavioral Indicators for stable workplaces (15 percent)

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on behavioral indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. The sample of workplaces have not experienced any reduction larger than 15 percent between any of the two years preceding the potential layoff.

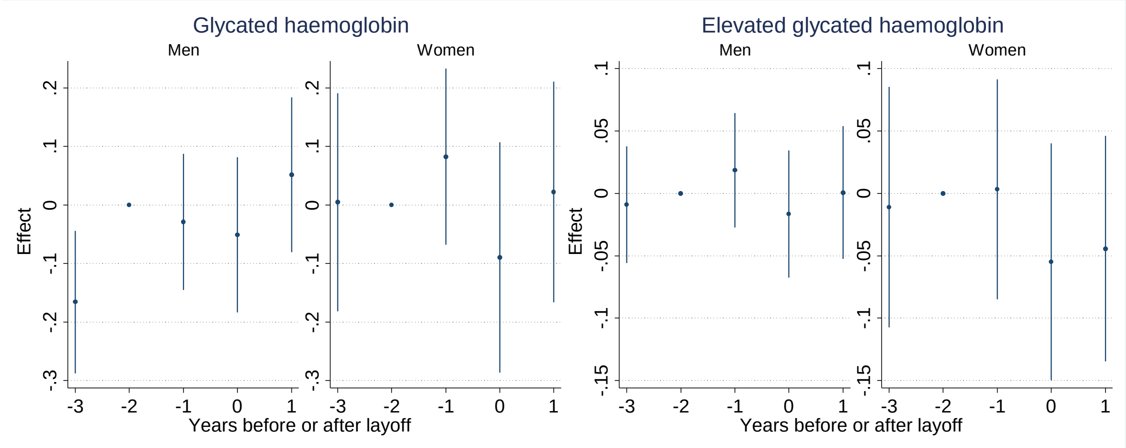

Figure A11. Effect of being Laid off for Individuals with T2D on Progression Indicators for stable workplaces (15 percent)

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on diabetes progression in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. The sample of workplaces have not experienced any reduction larger than 15 percent between any of the two years preceding the potential layoff.

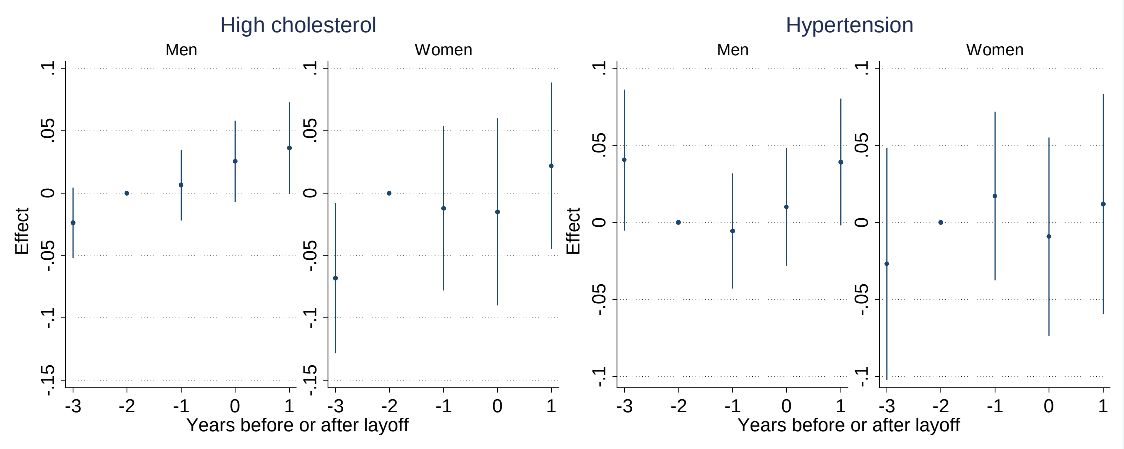

Figure A12. Effect of being Laid off for Individuals with T2D on Cholesterol Level and Hypertension for stable workplaces (15 percent)

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on cardiovascular risk in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. The sample of workplaces have not experienced any reduction larger than 15 percent between any of the two years preceding the potential layoff.

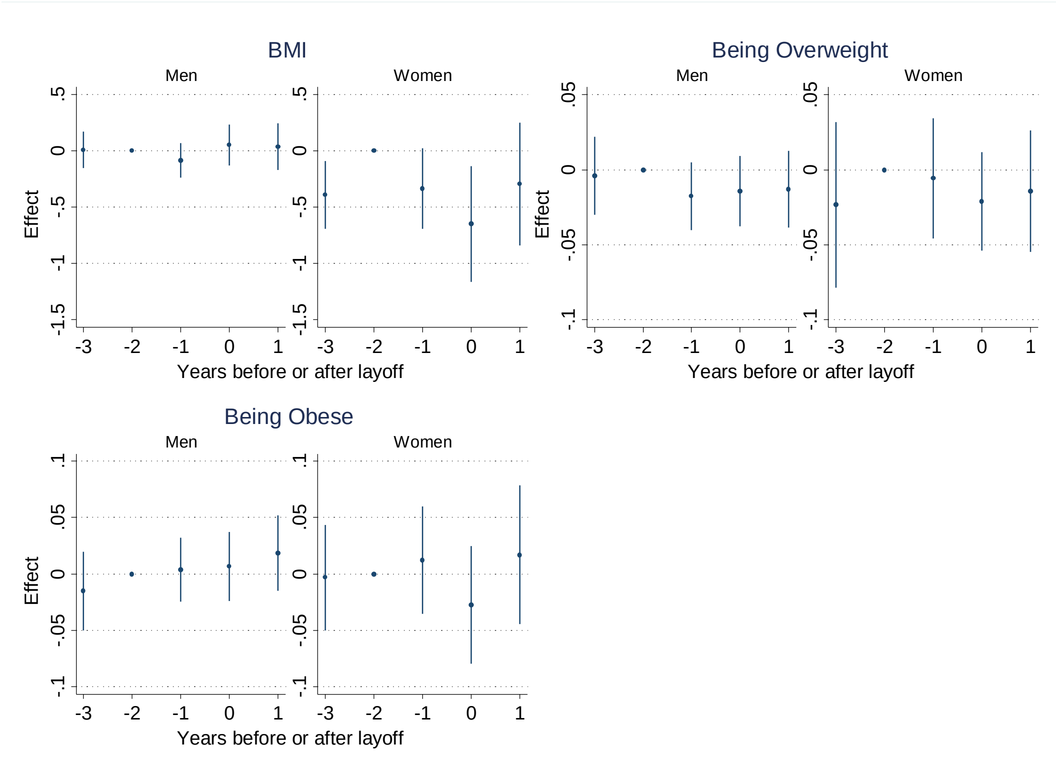

Figure A13. Effect of being Laid off for Individuals with T2D on Weight for (25 percent control sample)

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on weight in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. The control group consists of a 25 percent random sample of the non-laid off in each potential layoff year.

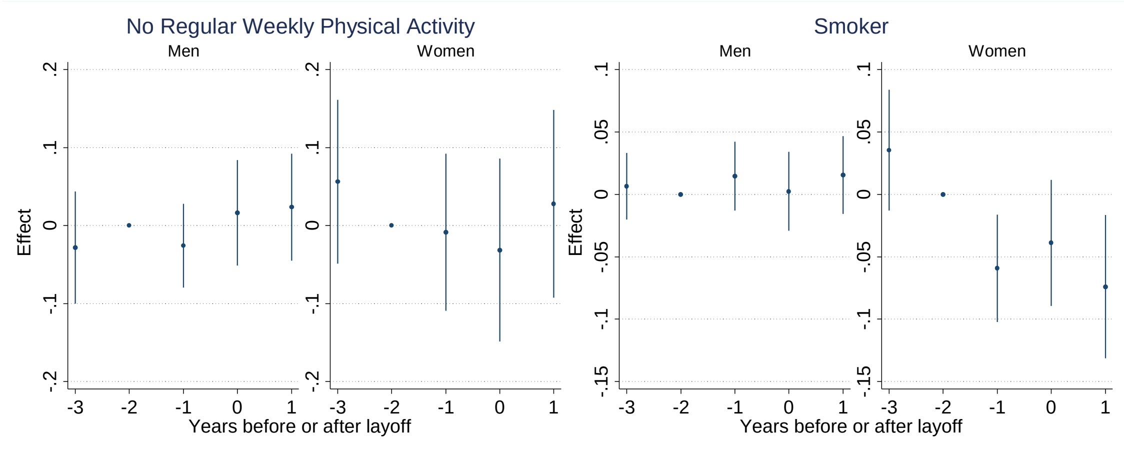

Figure A14. Effect of being Laid off for Individuals with T2D on Behavioral Indicators (25 percent control sample)

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on behavioral indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. The control group consists of a 25 percent random sample of the non-laid off in each potential layoff year.

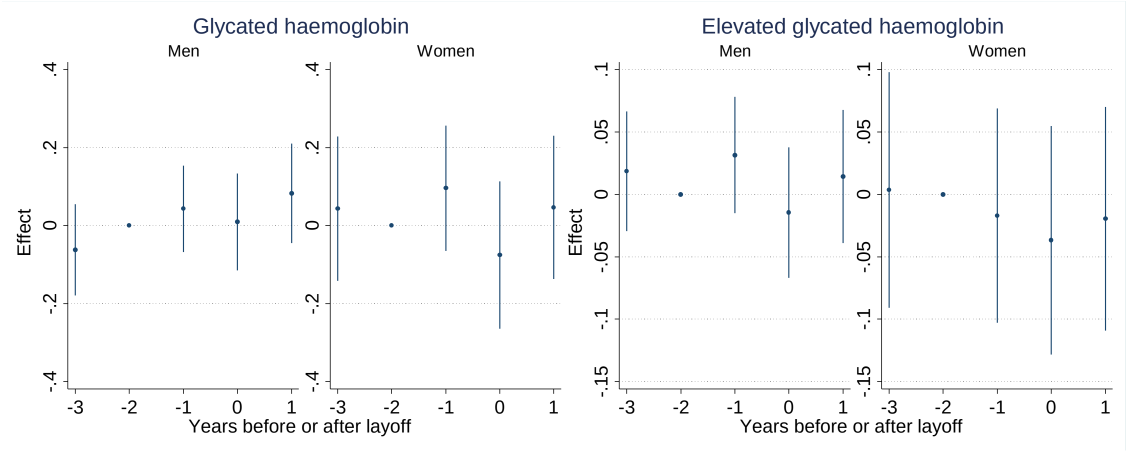

Figure A15. Effect of being Laid off for Individuals with T2D on Progression Indicators (25 percent control sample)

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on diabetes progression in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. The control group consists of a 25 percent random sample of the non-laid off in each potential layoff year.

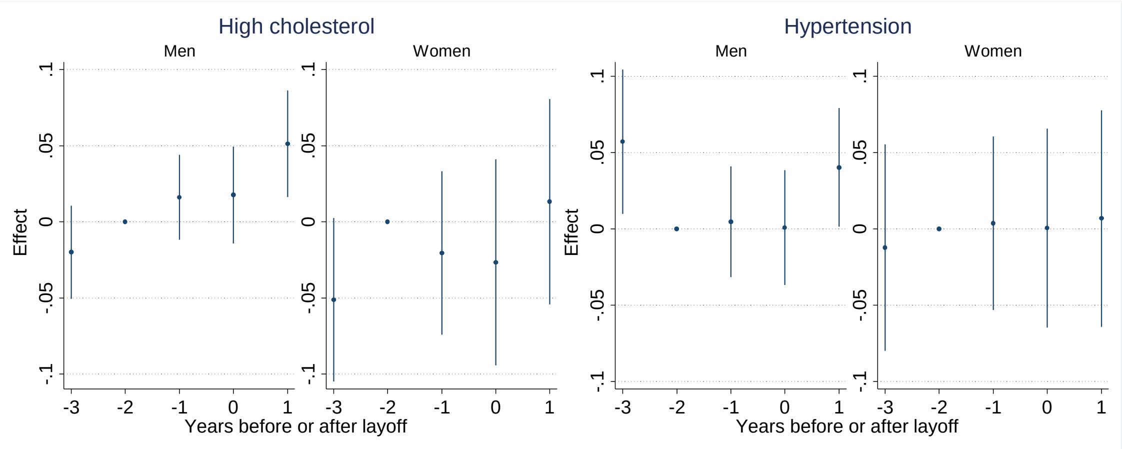

Figure A16. Effect of being Laid off for Individuals with T2D on Cholesterol Level and Hypertension (25 percent control sample)

Note. The figure displays ATET of job displacement, due to a mass-layoff in 2006–2009, on cardiovascular risk indicators in t-3, t-1, t, and t+1 with t-2 as reference points, for individuals diagnosed with type 2 diabetes. Displaced individuals are compared to non-displaced individuals at workplaces not subjected to mass-layoff. A mass-layoff is defined by a 30 percent reduction at a workplace between t-1 and t. All effects come from separate estimation of conditional Difference-in-Differences where treated and non-treated individuals are matched on propensity scores with IPW. The spikes represent 95 percent confidence intervals where standard errors are calculated with a Method of Moments estimator. The control group consists of a 25 percent random sample of the non-laid off in each potential layoff year.